THE ENGINEERS' DIGEST

REVIEW OF WORLD ENGINEERING PROGRESS

VOL. XI. No. 4 APRIL, 1950

IN THIS ISSUE

THE British Industries Fair this year, which is reviewed on page 139, can be regarded as the most outstanding in its history. Not only will it attain its greatest size ever, but a 50 per cent greater attendance of American and Canadian trade buyers over last year is expected. This forecast is based on a special publicity campaign undertaken for the B.I.F. in North America as part of the national drive to promote dollar sales of British products. Lowering of prices as a result of more efficient production methods and an improvement in delivery dates have, in particular, placed British goods in a more favourable position generally. This should also provide an inducement to countries experiencing difficulty in maintaining their purchases from hard currency areas.

* * *

The article by S. Tour and L. S. Fletcher on the hot machining of metals gives a remarkable illustration of the possibilities of the new technique of heating workpieces to temperatures ranging up to 1500° F ahead of the point of machining. The work can be heated either by means of an induction coil or by a gas torch. The rate of metal removal is doubled or trebled for steels, and in the case of a highly resistant cobalt-chromium alloy the rate of removal has been increased to 4·52 cu. in. per minute. The article gives details of the test equipment and the various induction coils designed for this work, and also contains a considerable amount of comparative data.

* * *

Flame-Cutting of plain carbon steels has become a well-established technique. In a stream of oxygen, the iron of the pre-heated steel oxidizes to iron oxides and thereby liberates sufficient heat to maintain the temperature at the cut. The oxides are fluid enough to drain out of the cut, which thus progresses automatically. This automatic action fails if alloy steels of pieces of cast iron are flame-cut, and external additions are required. Three patented cutting processes are on the market at present: the " Airco " system fluidifies the sluggish oxides by additions of pulverised sodium salts, the " Linde " system increases the cutting temperature by additions of powdered iron, and the latest " Cinox " process, developed in 1948, which we describe on page 124, propels the oxides out of the cut by injecting quartz sand particles mixed with the oxygen jet. The exact physical nature of the cutting action has not yet been established, but the technical success of these processes is undoubted. Although the cutting speed is slightly lower than that of the pure oxygen cutting of carbon steels, and the appearance of the cut edge not quite as smooth, the attainable depth of cut is very much increased and any alloy steels or types of cast iron can thus be cut. It may even be expected that flame-cutting of non ferrous alloys will become a technical reality in the near future. Another advantage of the patented processes is that they will cut across holes and gaps without difficulty so that stacks of sheet or plate can be cut cleanly without the use of any means for tight clamping. The only metallurgical precautions that seem to be necessary are the pre-heating of cast-iron pieces in order to prevent heat cracks, the pre-heating of air-hardening steels, and the immediate quenching of non-stabilised austenitic stainless steels (automatic means can be provided) so that fully austenitic structure is maintained and segregation avoided. A disadvantage of all three processes is the development of fumes, so that exhaust facilities and face masks should be provided wherever any of these processes is used on a large scale. It appears that with the " Cinox " process, the silicates of the sand combine chemically with the slag of the cut, as, according to present experience, no danger of silicose fumes has arisen anywhere; no special precautions need, therefore, be taken.

* * *

The main problem associated with change gears is the computation of gear trains, and this problem has been extensively dealt with in the first three instalments of the treatise on " Change Wheel Gearing." It frequently happens, however, that the desired gear train cannot be mounted. This, of course, is not due to disparity between the theory of computation and the practice of mounting; this month's instalment, see page 119, shows that a simple rule in mounting, easily remembered, not only avoids disappointments, but also minimizes the loads to be transmitted by the teeth of the gears.

Interesting problems arise if change gears have to serve also for indexing when cutting multiple start threads. Such additional requirements increase difficulties, but readers will find that they can be overcome in most cases.

HUNGARY

Electric Spark Machining

By I. Koncz. (From *Gép*, Vol. 1, No. 9-10, September-October, 1949, pp. 388-411, 38 illustrations.)

INTRODUCTION

The machining and cutting of hard alloys is a slow and costly process, as the specific machining output is low. Carbide tools, grinding and diamond powder are used in these processes, e.g., the drilling of a hole of $\frac{1}{4}$ in. dia. and $\frac{5}{16}$ in. length for a wire-drawing tool takes 6 hours with diamond powder. There are also components of machinery, e.g., those of gas turbines, which are made of carbides and borides, and these cannot be machined with cutting tools at all.

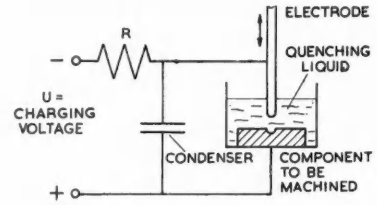


Fig. 1. **Schematic lay-out of the spark-machining apparatus of Vasiliev and Lazarenko.**

The new method of electric spark machining developed by Lazarenko and Vasiliev is used for the machining of the hardest alloys. Its principle is explained with reference to Fig. 1, showing the drilling of a hole in a metal component. This component is connected to the positive pole of a direct current source, while the drilling electrode is connected to the negative pole. The electrode periodically contacts the component and causes the condenser to discharge. The discharge takes the form of a spark at the point of contact, which becomes quenched by a liquid covering the component. Every spark discharge removes some of the material of the component and the electrode thus drills the hole. To be able to make consecutive contacts, the electrode is moved in the direction of drilling. The success of this process depends on the quenching operation, which should not permit the formation of an arc between the component and the electrode.

Grinding is carried out in a similar way. The electrode is a brass plate, disc, or cylinder rotating round the component. The accidental contacts between the surface irregularities of the electrode and the component cause spark discharges and material removal.

The electrode requires an oscillatory and a translational motion in the drilling process, to make periodical contact with the component. This can be achieved by mechanical or electronic means; Vasiliev uses the second method, causing the electrode to contact the component when the condenser is sufficiently recharged from the previous spark discharge. The time for recharging the condenser is determined for the simple circuit by its resistance R and capacitance C. The voltage U on the condenser will increase according to the formula:

$$U = U_0 \left(1 - e^{-\frac{t}{RC}}\right)$$

where U_0 is the voltage of the power source, t the time, and $e = 2{\cdot}71$. Vasiliev tried to find the correlation between the time of spark discharge observed on the component and the time constant RC of the condenser circuit. He machined a 1 in. dia. cylinder revolving round its axis with an electrode making about 10,000 contacts/sec, corresponding to a distance of 0·0004 to 0·0008 in. between neighbouring discharge craters on the surface. He found that each contact made gave rise to a multiple discharge. The machined volume of 0·02 cu. in./min was less than 1 per cent of the volume expected on theoretical considerations.

R. Holm investigated the nature of the spark discharge on switch contacts, where arcs are formed, and found that the weight loss of the electrode and the charge passing the arc are directly proportional. It is possible, therefore, that a similar relationship can be observed in the process of spark machining.

The inductance L of the charging circuit cannot be neglected. To avoid oscillations when contact is made, the following relation should apply:

$$R^2 \geq \frac{4L}{C}$$

Information on spark-machining was generally scanty and it was necessary to initiate basic investigations concerning its nature, using cathode-ray oscillographs. It was not known whether the quantity of machined material depends on the formation of an arc, or on the disintegration of material melted by the short-circuit current at the point of contact. The aims of the investigation were formulated as follows:—

(1) Building a spark-machining apparatus;
(2) Finding a relation between machining output and charging circuit data, starting with an equation given by R. Holm: $G = \gamma q$, where
  q .. is the charge passing the contact point during one full discharge of the condenser;
  γ .. is a coefficient, and
  G .. is the material loss.
(3) Qualitative investigations concerning the drilled holes;
(4) Comparison with other methods of drilling;
(5) Determination of the industrial usefulness of the method.

THE EXPERIMENTAL APPARATUS

(A) The Mechanical Part

The experiments were concerned with drilling holes. The main problem regarding the electrode tool was presented by the arrangement for its periodic motion. This motion was made independent of the charge of the

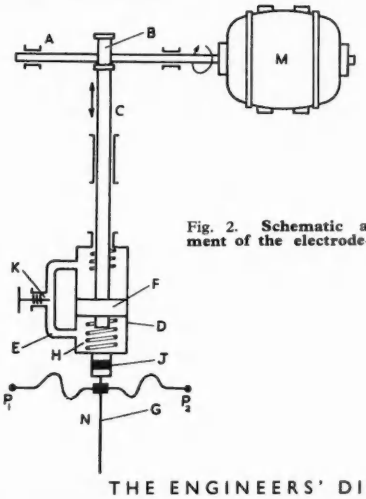


Fig. 2. **Schematic arrangement of the electrode-holder**

condenser to enable investigations to be made regarding the optimum contact frequency for a certain machining output. It was very important to regulate the electrode pressure when contact was made and to keep it constant. If the translational motion of the electrode was insufficient, no contact was made and, consequently, there was no output. If, on the other hand, the electrode pressure was very great, the contact surface increased, the heat then developed could not melt the metals, and the electrode became stuck to the component.

The electrode tool is schematically represented in Fig. 2, and a constructional arrangement is given in Fig. 3. The electrode G is connected to the driving cylinder D by an insulating piece J; the current is fed from the contacts P_1 and P_2. The motor M drives the piston F through the piston rod C. As the cylinder D is filled with oil, it would have to follow rigidly the motion of the piston and transmit it to the electrode. The release mechanism of the by-pass E and the valve K, however, enables the cylinder to move relative to the piston. The spring H presses against the piston during the whole drilling process and, by causing the oil to flow through the by-pass, gives the electrode the necessary forward motion. The release mechanism also regulates the electrode pressure. At the time of contact the piston moves downwards relative to the cylinder and drives oil through the by-pass. The oil-flow resistance determines the electrode pressure. The electrode is periodically driven up and down by this mechanism and moves forward in the direction of drilling. The maximum number of periods used was 6000/min. The electrode could sink to a maximum depth of 1 in. within a time ranging between 1·5 and 30 sec. The speed was regulated by the release valve K. Larger changes could be effected by changing to an oil of different viscosity, or by choosing a different spring. The best amplitude for the electrode oscillations was found to be 0·04 in.

The component was held in liquid on a small table, the liquid being contained in a glass cylinder. The component was weighed after every drilling operation. Jigs made of Pertinax were used to guide the electrode, as holes drilled without jigs were irregular.

The whole apparatus was fixed on the table of a milling machine.

B. The Electrical Part

The electrical circuit diagram of the drilling experiments is shown in Fig. 4. The current source, the d.c. generator G, was driven by the motor M. The voltage of the generator was regulated between 30 and 220V. The condensers C_1 to C_7 were charged through the variable resistance R. The capacity of each of three condensers was 16 μF, while the rest of the condensers were of various smaller capacities. The resistances R_1 and R_2 were of a very small value, the oscillographs being connected across them when taking oscillograms of the charging and discharging currents.

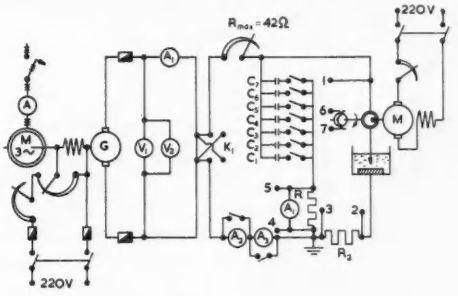


Fig. 4. **Circuit diagram of the power-supply.**

As sticking of the electrode to the component has to be avoided, instantaneous heavy currents are necessary to melt the metal and cause its removal by a kind of explosion. Such currents are only possible if the inductance L of the discharge circuit is kept very low, as the change of current at the time of making contact is given by the equation

$$\left(\frac{di}{dt}\right)_{t=0} = \frac{E}{L}$$

where i is the current, t the time and E the voltage. Great care has therefore been taken to make all connections as short as possible.

(C) The Measuring Instruments

Oscillograms of the tension and the current were taken in the discharge circuit in order to derive a better understanding of the drilling process. Fig. 5 shows oscillograms of the tension taken at different times during the drilling of a hole, which was performed in 10 min. It will be observed that the moment at which the voltage dropped to zero across the electrode and the component varied with every contact cycle. This variation with consecutive cycles, however, was slight, and it was possible to view the tension curve on the cathode-ray tube very satisfactorily. It is further noticeable that the condenser discharge output varied irregularly in the proportion 1 to 2·5. The data for this experiment

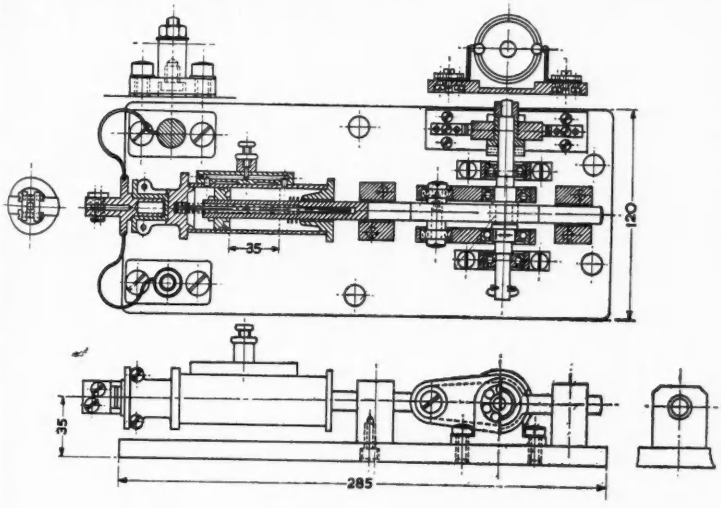


Fig. 3. **Constructional arrangement of the electrode-holder.**

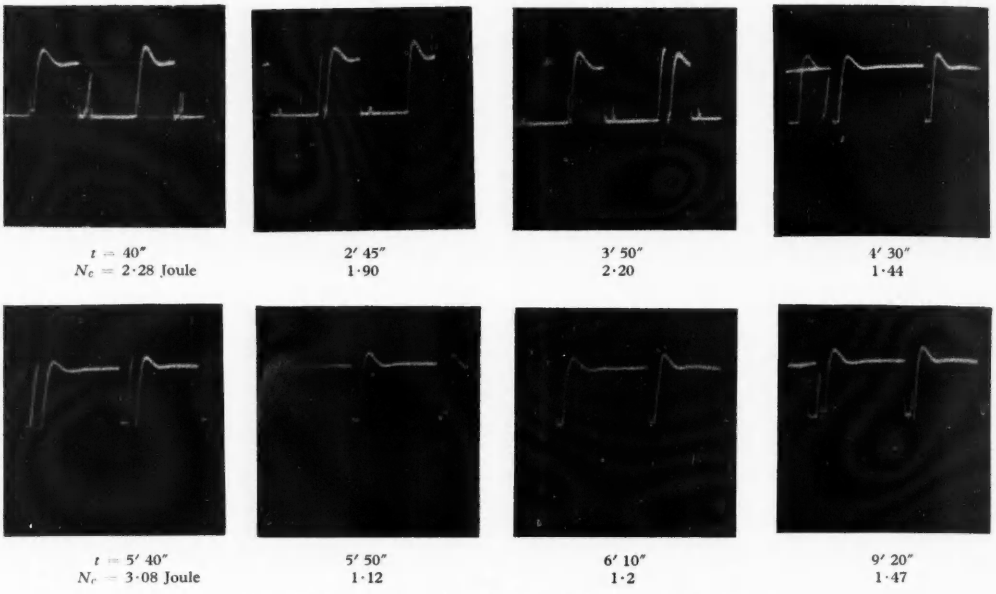


Fig. 5. Variation of the voltage oscillogram in the course of drilling.

were: Voltage 200 V; capacity 60 μF, duration of drilling operation 10 min; number of discharges 63,000; total charge 688 Coulombs: total output 65,600 Wsec; weight loss of the electrode 0·00246 lb; weight loss of the component 0·00172 lb.

The current curves varied too much with consecutive contact cycles, mainly due to the accidental nature of contact making at the highest points of the component and electrode surfaces. Viewing of these curves was, therefore, not possible. The oscillograms were photographed at a writing speed of about 3300 ft/sec at arbitrarily chosen instants. On the average, one out of five or six oscillograms was taken at the time of discharge.

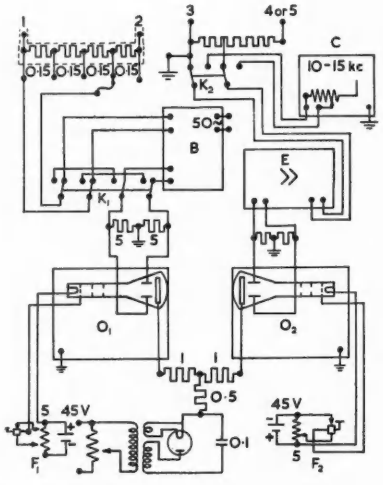


Fig. 6. **Circuit diagram of the measuring apparatus.**

The tension was directly applied to the plates of the cathode-ray tube. The voltage drop across a resistance, proportional to the current, was too small for the oscillograph and was, therefore, amplified in an electronic amplifier to a maximum value of 600 times the original.

Fig. 6 shows the circuit diagram of the oscillographs. O_1 is the oscillograph for the tension, 1 and 2 are the input contacts, B is the apparatus for the time axis, and F_1 the battery arrangement, which directs the cathode ray on the screen. O_2 is the oscillograph for the current, 3 and 4 the input contacts, E the amplifier, C a signal generator for the calibration of the oscillograph, and F_2 another battery arrangement for directing the cathode ray.

The Experiments on Drilling

The experiments were carried out with a view to determining the influence of the following factors on the drilling process:

(1) The material of the component;
(2) The material of the electrode;
(3) The diameter of the hole;
(4) The number of discharges;
(5) The voltage;
(6) The capacity;
(7) The charging resistance;
(8) The quenching liquid.

The drilling experiments started on Siemens-Martin mild steel of 47 tsi U.T.S. and 17 tsi Brinell hardness. The depth of the holes was about three times the diameter. 10 holes were drilled into each component. The component and the electrode were weighed after the drilling of every hole, in order to determine their respective weight losses.

The electrode chosen initially was made of brass; but its weight loss during drilling was very large and, therefore, this material had to be abandoned. The maximum forward movement of the electrode holder, which was 1 inch, was not sufficient to reach the bottom of a $\frac{3}{8}$ in. hole with one electrode. Most metals melted away at the same speed as brass. However, tungsten was found to be satisfactory. The tungsten electrodes

used were 0·0134 in. in diameter and great care was taken to adhere to this size and preserve metallurgical uniformity. The holes drilled were always larger than the electrode diameter.

The quenching liquid used was petroleum, which is also used as vapour in Poulsen generators, the high-frequency arcs being very efficiently deionized by this liquid.

The main variables of the experiments, apart from the above factors, were the voltage, the capacity and the charging resistance. The voltage was varied in steps and its values were 23, 40, 50, 100, 150 and 200 volts. Similarly, the capacity values were 16, 30, 90 and 140 μF, and the charging currents 2-4, 5-6, 8, 12, 16, 23, 30 and 40 amp. These factors influence the discharging current at the time of contact-making and of arc formation when contact ceases.

The voltage curves of every experiment were photographed, when there was a marked change in its shape, as shown in Fig. 5. At the beginning of the drilling process the electrode in contact with the component can be compared to an oil-immersed switch. The electrode seems to stick to the component, hence the long no-voltage period in the first oscillograms of Fig. 5, a certain force being applied by the electrode holder to raise the electrode. When the hole becomes deeper, the pressure developed round the molten metals prevents the electrode from sticking to the component. Therefore, as can be seen on the later oscillograms of Fig. 5, the contact time (characterized by no voltage) is reduced. This reduction in contact time can also be observed on the ammeter of the charging current, which drops considerably in the later phases of the drilling process.

(*To be continued*).

U. S. A.

Isotopes as Tools of Engineering

Compiled from articles by

P. C. AEBERSOLD (*Mechanical Engineering*, Vol. 71, No. 12, December, 1949, pp. 987–990, 7 illustrations.)

C. E. BIRCHENALL and W. O. PHILBROOK (*The Iron Age*, November 10, Vol. 164, No. 20, 1949, pp. 77-82, 2 illustrations.)

F. OGBURN and A. BRENNER (*Journal of the Electrochemical Society*, Vol. 96, No. 6, December, 1949, pp. 347-352, 1 illustration.)

RADIOISOTOPES, now obtained as by-products of atomic energy, are among the most powerful and versatile tools ever put at the disposal of research workers. When used as *tracer* atoms, they provide a method of analysis which is more sensitive and more specific than any other physical or chemical method of analysis now known. As sources of *ionising radiation*, they have proved in many instances more versatile and better applicable than radium or X-ray machines.

One of the interesting features of radioisotopes (i.e., varieties of an element having identical chemical properties, but emitting detectable radiation or radiations by which they may be traced or identified) is that one cannot predict when a given atom will disintegrate, but can only say that each unstable atom has a characteristic probability of decomposing in a chosen time period. Of any given collection of such atoms, the number that will decompose is directly proportional to the number present; if half of them disintegrate in a certain time period, then half of those still remaining will disintegrate in the next likely time period, and so on. The half-life for radioactive decay is, then, one of the ways to identify a specific radioisotope. The other method of identification is by the nature and energy of the radiation emitted when the isotope decomposes.

The useful radiations given off in decay reactions are the beta and gamma rays. These have quite different properties. The former is an electron of either negative or positive charge which loses energy fairly rapidly by ionising matter through which it passes. Beta rays of 0·5 MeV energy will be effectively stopped by 0·107 gr/cm² of aluminium. On the other hand, gamma particles are high-energy X-rays having no charge or mass. They penetrate matter readily, causing little ionisation. An average gamma activity of the same energy as the above mentioned beta radiation will require 9·0 gr/cm² of aluminium to reduce the beam intensity to only one half of its initial value. A third type of radiation given off are the alpha rays, but at present there is little occasion to deal with alpha particles in industrial applications.

The instruments developed for detecting and assessing the radiations emanating from radioisotopes are relatively simple and inexpensive, which greatly contributed to the rapid spreading of the use of this technique in industry.

During the last two years, an increasing number of radioisotope applications has been made in industrial research laboratories. As tools of analysis, radioisotopes may be used in at least three different ways, two of which, "tracer analysis" and "isotope-dilution analysis," are quantitative, and the third, "activation analysis," may be semi-quantitative, although it has usually been considered as primarily qualitative.

SIMPLE TRACER ANALYSIS

Tracer analysis is the most direct and the most frequently used way of employing radioisotopes. The method consists of "tagging" or labelling a particular substance with the radioisotope and later determining its presence or absence in an agglomerate of other materials. By using a radioactive tracer, this determination can be made at concentrations far below those permitted by other methods. For short-lived materials, the presence of as little as 10,000 atoms or 4×10^{-19} grams can be detected, but even for radioactive carbon 14, which has a half-life of over 5000 years, the sensitivity of detection is over a million times that of chemical methods.

In the quantitative application of this method, the radioactive tracer element or compound is added in a known amount at one stage of a reaction or process, and its concentration determined by radioctivity measurements at a later stage. One limitation of this technique is that the total amount of the material being traced must be determined accurately in the final stage of the reaction or process.

ISOTOPE-DILUTION ANALYSIS

This is a modification of tracer analysis. The radioactive element is mixed in known ratio with the stable form of the same element and added to the process materials. Any change in this ratio will be due to the dilution caused by the amount of that element already present in the process materials. The unknown amount of element originally present in the system is thus determined by the change in the ratio of radio-

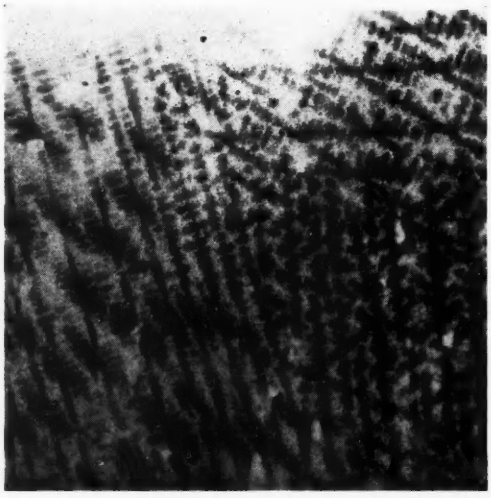


Fig. 1a. **Autoradiograph of a Ni, Cr, W alloy with W^{185}.** (Tungsten-rich areas are dark; 25 diameters. Exposure in air.)

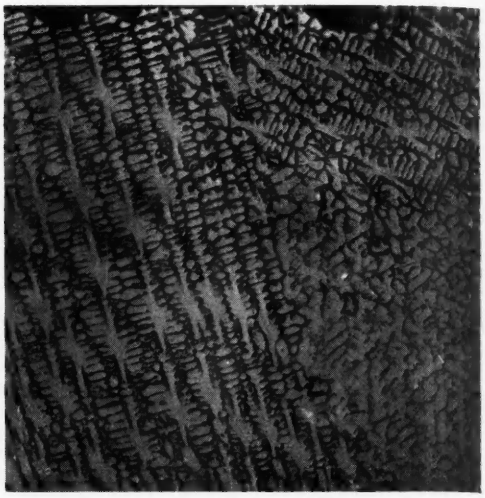


Fig. 1b. **Photomicrograph of the same surface as** Fig. 1a. (Tungsten-rich areas in Fig. 1a coincide with dendrites in Fig. 1b.)

active to stable element. The advantage of this method is that it does not require quantitative chemical determination of the total amount of element. It is only necessary to measure the ratio value, and this may be determined on unknown portions of the total material. The disadvantage of this method is that its accuracy depends on the degree of dilution which takes place.

Activation Analysis

Activation analysis involves the irradiation of the unknown sample in the nuclear reactor, and the subsequent identification of the radioisotopes induced in the sample. The various radioisotopes thus produced are identified by their specific radiation characteristics. This method of analysis is mainly qualitative. It is particularly useful where the concentration of the unknown element is too low to be identified by chemical or spectroscopic methods, or where standard methods of analysis are not satisfactory because of interfering contaminants. This method, however, has certain serious limitations. A nuclear reactor or some other bombarding device is necessary for irradiating the unknown sample, as the element to be analysed may not have a suitable radioisotope for measurement, and several elements in the material may be activated which have radioisotopes with radiation characteristics so similar as to prevent their differentiation.

Industrial Applications

Radioisotope technique has already proved extremely valuable to the chemical and mechanical engineer. This is best illustrated by a few examples.

Self-Diffusion Measurements in Iron and Cobalt: The radioisotope method is the only one so far known which has the specificity to permit studies of self-diffusion. The radioactive material is plated on a disk and measurements made of the amount of activity on the surface. The sample is then heat treated and a second measurement made. The decrease in the amount of surface activity is a measure of the diffusion which has taken place. The same technique can be used to measure the diffusion between like as well as unlike metals.

Locating Tungsten in a Ni- Cr- W- Alloy: By using a tracer it is possible to locate a particular constituent in a solid solution and follow its movement as the metal is subjected to various types of treatment. For example, radio-tungsten 185 has been used to determine the location of tungsten in a 70 Ni—25 Cr—5 W—alloy. By using an auto-radiograph—a picture obtained by allowing the radiation from the radioisotope from the sample to expose a photographic plate placed in contact with it—in conjunction with a photomicrograph, it was possible to show that the tungsten is located in the dendrites. Fig. 1a shows the autoradiograph, Fig. 1b the photomicrograph.

In a cobalt-base alloy, it was shown that the tungsten is generally associated with the intermetallic compounds and solid solutions between the dendrites.

Studying Friction and Wear. One of the most interesting and straightforward applications of the radioactive tracer technique is concerned with studying the phenomena of friction and wear. This method is reported to be ten thousand times more sensitive than the electrographic and X-ray photographic methods. It also permits more detailed location of areas of wear.

In one type of friction study, radioactive piston rings in petrol and Diesel engines were used. The piston rings were made radioactive by irradiation in a nuclear reactor. The rate of wear is easily followed by making periodic measurements of the radioactive iron in the lubricating oil. This method is very rapid, can be carried out without dismantling the motor, and permits easy determination of the relative merits of various lubricating oils under exactly identical conditions. Some of the radioactive iron worn from the piston rings becomes deposited on the sides of the cylinder walls. After the experiment has been carried out, the engine may be dismantled and the detailed location of the radioactive material on the cylinder walls determined.

Radioisotope methods can also be used to study the migration of metallic ions into insulating compounds and the mechanisms of adsorption, corrosion, surface wetting, and detergency, in cases where chemical methods are inadequate.

Studies of Oil Flow in Pipe Lines. It was found that a radioisotope makes an excellent marker for locating the boundary between two types of crude oil flowing through the same pipe line. The radioactive indicator can be added just after one crude oil has passed through this particular section of the pipe line, and just as the next type is introduced. Many miles further along the pipe line the detection of radiation on the outside of the pipe will indicate the presence of the radioactive material and the location of the boundary. With this

method, the boundary between the two crudes is much more sharply defined than by the conventional methods, and the costly flushing operations are unnecessary.

Radiographic Testing. Radioactive cobalt, for instance, may be used in the radiographic examination of welds and castings in the same way as radium sources and X-ray machines are being used. Because cobalt can be machined to any desired shape and size before being made radioactive in the nuclear reactor, it has been found to be somewhat more versatile in its application. This radioisotope can be prepared to have a gamma-ray output per unit weight several times that of radium. It is also possible to obtain at lower cost radiocobalt sources having total activities many times greater than available radium sources. For radiographic testing of thin and low-density materials, other radioisotopes with less penetrating radiation may prove useful. Fig. 2 illustrates the use of a radioisotope in making a radiographic examination of a cast valve.

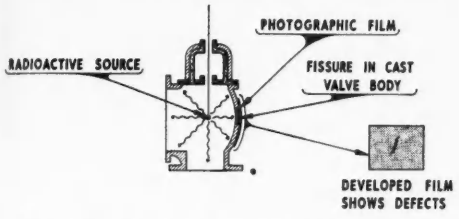


Fig. 2. **Radiographic examination of a cast valve.**

Application to Gauges. If it is to be used in a level gauge, the radioactive source is placed in a float riding on the surface of the liquid, the level of which is to be determined. As the level of the liquid rises, the source comes closer to the radiation detection instrument mounted on top of the vessel containing the liquid, and there is a corresponding increase in the amount of measured radiation. A different method has been used to determine the height of liquid steel in a cupola. The radioactive source is mounted on the outside of the cupola and the radiation detection instrument is mounted at the same height on the opposite side. The gamma radiation from the radiocobalt source is directed to pass through the cupola to the detector. When the level of the molten steel rises above the height of the source, part of the radiation is absorbed and there is a marked decrease in the measured radiation.

Thickness gauges operating on the same principle have been in use for some time for measuring the thickness of paper, glass, steel, rubber and other materials. One of the advantages of these gauges is that they allow measurements to be made without mechanical contact, which gives higher sensitivity and higher precision and eliminates the possibility of ripping or tearing the material.

Oxidation of Metals. In the field of solid-solid reactions, tracers are used to study the mechanism of oxidation of metals. A thin layer of radioisotope of the metal is placed on the metal, which is then exposed to controlled oxidising conditions. An analysis of the distribution of the radioisotope through the scale layer indicates whether oxide formation took place by diffusion of metal through the oxide to the atmosphere, or by diffusion of oxygen through the scale to the metal. Practical applications include investigation of corrosion, protective oxide films, passivation, etc. A closely related essential application of tracers is the study of the exchange of iron atoms between molten iron and a slag containing iron oxide in equilibrium with the bath. This may help to explain oxidation on the open hearth, because iron oxides are generally believed to be the vehicles which carry oxygen from the furnace atmosphere through the slag to the metal bath. The study can be made either by adding radio-iron to the metal or a radioactive iron oxide to the slag, and then to sample periodically in order to learn how long it takes for the radioactivity in the other phase to reach a constant level.

Influence of Organic Sulphur on Coking Process. Investigations were made to learn whether pyritic sulphur in coal behaves differently from organic sulphur during the coking process. Tracer methods provided the only possible way of distinguishing between sulphur atoms from two different sources and following them through an involved process.

Study of Electroplating Processes. Better understanding of the mechanism of electrodeposition in various plating processes has resulted from recent studies using radioactive tracer techniques. An outstanding example is that of chromium plating. For commercial chromium plating the chromic-acid bath is at present practically the only chromium plating solution in use. This bath is prepared by dissolving CrO_3 and a little sulphuric acid in water. Initially, all of the chromium in the solution is in the hexavalent state; but when the plating current is applied, some trivalent chromium is formed by reduction of the hexavalent chromium at the cathode. This has led to numerous investigations into the mechanism of the electrodeposition process to determine whether the chromium is deposited directly from the hexavalent state or through the trivalent form.

By tagging either the trivalent or the hexavalent chromium ion in a chromic acid plating bath with radioactive chromium 51, it was conclusively shown that metallic chromium is deposited out of the bath from the hexavalent state rather than from the trivalent state as had previously been suggested.

Limitations

There are three major difficulties which may be encountered: 1. Extraneous and perhaps misleading counts from radioactive impurities. 2. Uncertainty in interpretation of counting data, either because the decay pattern of the isotope being measured is complex or because it has not been adequately studied and reported in the literature. 3. Inherent lack of resolution of photographic techniques for fine detail of structure.

Many irradiated units in which active materials are produced contain radioisotopes of several different elements because of concurrent action upon these elements in the atomic pile; the unwanted activities are sometimes much stronger than those of the element desired. This often happens in the preparation of certain irradiated units for which it is not possible to use a target material in its elemental form.

On the other hand, target materials which presumably undergo only one reaction to form a single radioisotope under neutron bombardment may contain traces of radioactive contamination either by accident or, more likely, because no material is absolutely pure, and the minor impurities in the starting material may be converted to radioactive species with high efficiency. If such radioactive contaminants are known or suspected to be present, they may be removed by chemical separations. The danger lies in the unsuspected presence of a small amount of radioactive contamination which may be completely masked in the original material by the radiation of the desired isotope, but which may follow a different path in accordance with its chemical identity in the process under investigation and may give rise to evidence of radiation where there should be little or none.

The difficulties listed under points 2 and 3, though very complex in practice, are self-explanatory in principle.

Other limitations exist as to the kind of experiments

which may be done with tracers. Some elements which, for instance, the metallurgist might want to study, for example, magnesium, do not have radioisotopes of long enough half-life to allow time for conducting experiments. Other elements, such as nickel, require different types of counting tubes. Radioisotopes of a few metals cannot be produced in the atomic pile; manganese is one of these. Radiomanganese can be made by the cyclotron, but in very limited amounts and at much higher cost than pile-produced isotopes.

On the other hand, much work with isotopes can be carried out without any difficulty.

HOLLAND

The Powder Coupling

By W. F. BLADERGROEN. (From *Polytechnisch Tijdschrift*, Part A, Vol. 5, No. 1-2, January 10, 1950, pp. 22a-24a, 3 illustrations.)

THE Smevrie Company, of Breda, Holland, has made available for publication the following details of a new type of coupling which has been successfully developed by the French Company Société Ranzi-France.

This new coupling employs a mixture of metallic powders treated with graphite, instead of a fluid, for the transmission of torque. The powder and graphite mixture is insensitive to heat, up to a certain temperature limit, and its viscosity varies according to the power being transmitted.

Extensive theoretical and practical investigations carried out over a period of twelve years have served to determine the fluidity of metal powders under various loads and different kinematic conditions, and have given ample proof of the suitability of metal powders as a torque transmitting medium in couplings.

The coupling consists of a light-metal or steel casing rigidly connected to the driving shaft, and a light-metal disc situated inside the casing and mounted on the output shaft, which is connected to the driven machine either directly or through a pulley, as shown in Fig. 1.

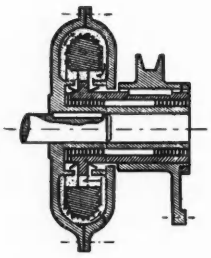


Fig. 1. **Sectional view of Ranzi coupling.**

When the driving motor (or engine) is started up, the casing rotates while the inner disc remains stationary. As the motor reaches its normal running speed, the disc is gradually accelerated until it reaches the speed of the input shaft. The powder mixture, owing to the centrifugal forces generated, is forced outwards against the periphery of the casing. As a result of the special design of the casing and disc profiles, the powder is compressed during its outward motion and also circulates in the same way as a fluid. It thus gradually forms on the output side of the casing a relatively thick mass which builds up round the internal disc and finally entrains it, so that at full speed it is revolving at the same speed as the input shaft and casing.

During the starting period of the driving motor and the driven machine, the powder behaves first as a powder, then as a fluid of increasing density, and finally as a solid body. When the motor is shut down, the speed with which the coupling comes to a standstill depends on the quantity of powder contained in the casing.

The coupling is normally non-reversible, as reversible systems have a much lower efficiency, and it can only transmit power in one direction, i.e., from the motor to the driven machine. Special designs can, however, be developed to fulfil both these requirements. The coupling also gives automatic protection against overloads, as the maximum power which can be transmitted depends on the quantity of powder in the coupling. As soon as the overload is dropped and normal load conditions are reached again, the coupling stops slipping and rotates as a single unit.

The coupling can slip for a very long period of time and thus presents the possibility of driving machines having heavy starting characteristics by means of extremely low power motors. Furthermore, it is also possible to use a second coupling and a second motor at the other end of the driven machine for reversing the direction of rotation. The coupling of the second driving motor will slip until the power from the first motor is cut off, and when the second motor begins operating it will gradually take over and rotate the machine in the opposite direction.

The " Ranzi " automatic coupling has the following advantages :—

(1) Fully self-lubricating coupling, no maintenance being required ; (2) small overall dimensions, and simple design consisting of two basic components ; (3) 100 per cent efficiency under normal operating conditions, as compared with a 95 per cent efficiency for fluid-drive type couplings ; (4) slip varying from 100 per cent to zero during starting ; (5) increase of speed at a very uniform rate ; (6) no costly coupling installation or special electric motors required ; (7) slip sustained over long periods (30 min.) without damage ; (8) no additional overload protection required ; (9) possibility of using simpler control equipment for remote control of driven machines, less servicing and less risk of mechanical failure ; (10) possibility of coupling several asynchronous machines to a single shaft system.

The coupling is made in six standard sizes varying between 15 and 38 cm (6 and 15 in.), with a torque carrying capacity from 1 to 100 hp.

The following example illustrates the favourable results which can be obtained by using Ranzi powder couplings :—

Use of Ranzi couplings in textile manufacture :— Spinning factory with 500 bobbins, producing 5 tons per 8-hour day. The saving is due to the use of motors which are exactly suited to the work to be done, without requiring additional overload capacity for starting.

	Old system	New system with Ranzi couplings	Improvement in per cent
Installed capacity ..	1116 kW	909·7 kW	22·8
Daily power consumption	6693 kWh	6379 kWh	5
Average power factor	0·67	0·798	—
Total current from mains supply (500 V.)	1841 amp.	1550 amp.	18·5
Power required per bobbin	0·0223 kW	0·0182 kW	—

Influence of Twist in Turbine Blades on Natural Frequencies and Directions of Vibrations

By J. GEIGER. (From *Schweizerische Bauzeitung*, Vol. 68, Nos. 3 and 4, January 21 and 28, 1950, pp. 17-21 and 38-41, 30 illustrations.)

LONG turbine blades are often twisted so that the steam or gas flow may be improved and the fluid energy better utilized. The angle of twist of blade tip relative to blade root seldom exceeds 30 degrees, but tests have been conducted with angles up to 45 degrees, where the changes in vibration, due to twist, are more pronounced. Rectangular bars with cross-sectional width/depth (b/h) ratios from 2/1 to 20/1 were chosen. Such bars are easy to manufacture accurately and, within the limits of elastic bending, any arbitrary form of cross-section can be conceived to be replaced by a rectangle of equal principal axial moment of inertia. Ratios of b/h smaller than 2/1 have not been investigated, as the axial moment of inertia for a given constant direction through the centre of gravity of a nearly square twisted bar does not substantially change with the twist, and the vibrations cannot, therefore, differ noticeably from those of the corresponding straight bar. The author has found certain rules* for the frequency of vibration of straight blades tapering towards the head (see Section V) but these rules are not applicable to twisted bars where the axial moment of inertia for vibrations normal to the longer side b of the cross-section at the foot increases with the angle of twist, i.e., with increasing distance from the foot of the bar (see Figs. 1 and 2). New rules have to be derived from experiments.

I. THE FUNDAMENTAL FREQUENCY

The foot of the bar was welded to a baseplate rigidly screwed to a heavy block of 3 tons weight which was placed into a push-pull fatigue testing machine and oscillated with a purely sinusoidal movement of accurately known and measurable amplitude. The cantilever vibrations of the bar were measured near the foot so that the inertia of the measuring linkage would not influence the vibrations. This was checked by measurement and calculation of the vibrations of a straight bar. The measuring device was also attached to a point more than double the distance from the blade root, and no difference in the measured frequency could be observed in spite of the larger amplitude of linkage movements. The free head of the vibrating bar carried a very small silver point tracing the direction of its vibrations on an indicator card which could be lowered into contact with the point. Vibrations were produced by initial deflection and free swinging of the bar or by oscillations of the heavy base in resonance with the natural vibrations of the bar. For most of the tests, the base was oscillated, or the bar deflected, in a direction normal to the longer side b of the foot cross-section.

The fundamental frequencies of twisted bars hardly deviate from those of straight bars (see Fig. 3). Profiles of $b/h = 2/1$ show a slight increase in fundamental frequency with the total angle of twist of head relative to foot, whilst the profiles $b/h = 6{\cdot}1/1$, 10/1, 20/1 show a slight decrease of up to 3 per cent. This lies within the range of unavoidable errors in workmanship and measurement and may also be due to damping. The vibration trace on the indicator card is always a straight line, and the angle of the trace relative to the direction of oscillation of the base, or direction of initial deflection of the bar, pointed in the same sense as, and was about 1/3 of, the total angle of twist. (See Fig. 4).

II. THE FIRST HARMONIC (SINGLE-NODE) VIBRATION

Straight bars show a perfect upper node apart from the obvious node at the fixed end. The profiles 2/1 and 4/1 with a total angle of twist of 45 degrees show a higher first harmonic frequency than the corresponding

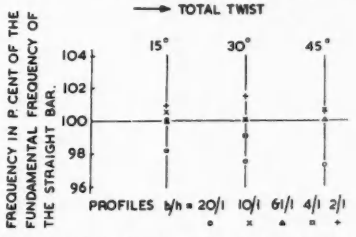
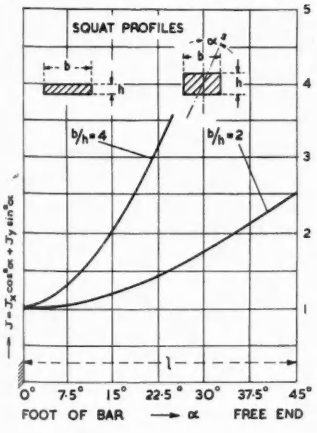
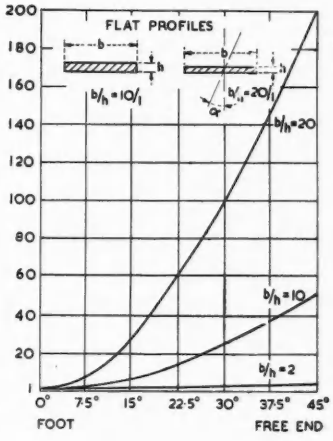


Fig. 3. **Change of fundamental frequency of twisted bars without taper as a function of the total twist of cross-section at the free end relative to cross-section at the foot of the bar.**

*J. GEIGER, Determination of natural frequencies of tapered turbine blades, Werft-Reederei-Hafen, 1943, p. 49.





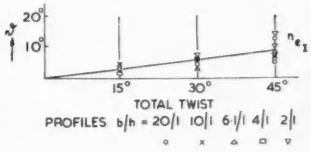


Fig. 4. **Angle of vibrations at the free end relative to the direction of the exciting oscillations, as a function of the total twist of the bar.**
Bar without taper. Fundamental vibrations. Frequency n_{e1} differs for different bars, see Fig. 3.

Figs. 1 and 2 (left). **Axial moments of inertia of rectangular cross sections, inclined at angle α to the direction of vibration, about the neutral axes normal to this direction.**

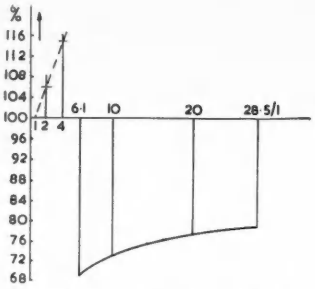


Fig. 5. **Change of first harmonic frequency, at 45 degrees total twist, as a function of the flatness (b/h) of the profile.**

Frequency in per cent of the first harmonic frequency of the straight bar.

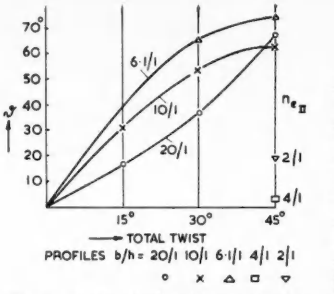


Fig. 6. **Angle of vibrations at the free end relative to the direction of the exciting oscillations, as a function of the total twist.**

Bar without taper. First harmonic vibrations. Frequency n_{eII} differs for different bars, see Fig. 7.

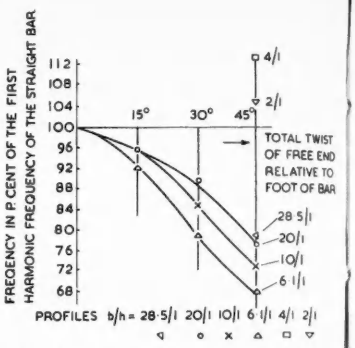


Fig. 7. **Change of first harmonic frequency of twisted bars without taper as a function of the total twist.**

straight bars, the increase being larger than for the fundamental frequency and rising distinctly with increasing flatness of the profile (Fig. 5 dotted line). The angle of the vibrations at the head again changes in the same sense as, and remains much smaller than, the total angle of twist (Fig. 6). If the flatness of the profile is now increased (b/h = 6·1/1 and more), *new natural vibrations of different form and direction* replace the expected first harmonic vibrations of increasing frequencies:

(a) If the baseplate is given an exactly sinusoidal oscillation normal to "b" at the foot of the bar, the different cross-sections along the bar do not all move in the same direction. Looking in a direction normal to the oscillations of the base, one has the impression of a first harmonic vibration with its node considerably further from the free end than the node of a straight bar. Looking parallel with the exciting oscillations, a distinct fundamental vibration without an upper node is seen. Looking from above, one recognizes the superposition of the two vibrations, which is different for different cross-sections of the bar. Thus, no real first harmonic exists, although the pronounced resonance phenomenon shows that the combined "K_{II}-vibration" is a natural vibration.

(b) In contrast to the first harmonics of the squat profiles, 2/1 and 4/1, the K_{II}-frequencies are pronouncedly lower than the first harmonic frequencies of the corresponding straight bars (Fig. 7), but the difference diminishes with increasing flatness of the profile (Fig. 5). Moreover, identical K_{II}-vibrations are produced by excitation normal to the long or the short side at the foot of the vibrating bar. Only the 6·1/1 profile with 15 degrees total twist has two apparently distinct K_{II}-frequencies, 3·5 per cent apart.

(c) Vibration traces of the free end still show straight lines, oblique in the same direction as, but now at a much larger angle than, the total twist of the bar (Figs. 6 and 8). The upper node of a straight bar lies at 0·201 l, the apparent node of a 10/1 profile with 45 degrees total twist at 0·284 l, from the free end (l = blade length).

III. HIGHER HARMONICS

Higher harmonics were observed for the profiles 6·1/1, 10/1, 20/1 as far as the frequencies were below 4500 vibrations per min.

Profile 6·1/1: A K_{III}-frequency, identical for excitation normal to the long or the short side at the foot of the bar, was observed to be 50·6 per cent above K_{II} for bars with 30 degrees total twist, 95 per cent above K_{II} for 45 degrees total twist. The pure second harmonic frequency of the straight bar would be more than 180 per cent above its first harmonic.

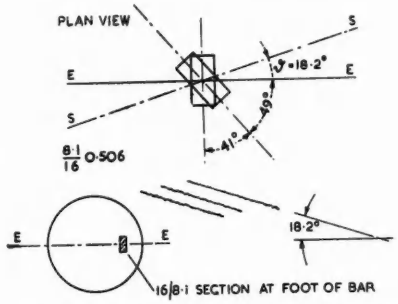


Fig. 8. **Three traces (bottom, centre), copied from indicator card as seen from below, showing the angle of vibrations at the free end relative to the direction of excitation (normal to the longer side b at the foot of the bar).**

EE = direction of excitation; SS = direction of vibrations at the free end.

Profile 10/1: For all observed angles of total twist, the K_{III}-frequency for excitation normal to "b" at the foot lies remarkably close to the second harmonic frequency of the straight bar (Fig. 9). The angle between the vibrations at the free end and the exciting oscillations roughly coincides with the angle of total twist (Fig. 10). Excitation normal to the short side at the foot produces a new fundamental frequency higher than the corresponding fundamental frequency of the straight bar and increasing with total twist (Fig. 11). The angle between the vibrations at the free end and the exciting oscillations is roughly 60 per cent larger than the corresponding total twist.

Profile 20/1: The K_{III}-frequency for excitation normal to "b" at the foot is definitely below the second harmonic of the straight bar and falls with increasing total twist (Fig. 9). The angle of the vibrations at the free end is much less than for the 10/1 profile (Fig. 10), but inaccuracies may be greater. A K_{IV}-frequency can be detected and roughly coincides with the third harmonic of the straight bar. However, excitation normal to the short side "h" at the foot produces remarkable new fundamental vibrations. Their amplitude still swells out at resonance, but the resonant vibrations are no longer sinusoidal. Bars with 15 degrees total twist show a strong superimposed vibration of about double the frequency. With 30 degrees total twist, this phenomenon is very striking and a new, much slower, frequency becomes apparent. The latter is the fundamental frequency for excitation normal to "b" at the foot of the bar. With 45 degrees

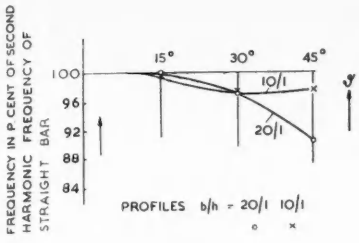


Fig. 9

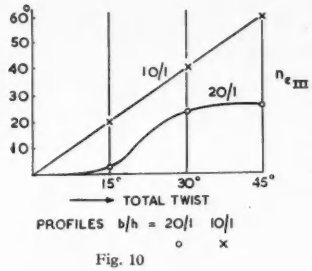


Fig. 10

Fig. 9. **Change of second harmonic frequency of twisted bars without taper as a function of the total twist of free end relative to the foot of bar.**

Fig. 10. **Angle of vibrations at the free end relative to the direction of the exciting oscillations, as a function of the total twist.**

Bar without taper. Second harmonic vibrations. Frequency n_{eII} differs for different bars, see Fig. 9.

total twist, the superimposed vibrations even predominate. Not only the free end but also, to a different extent, all the cross-sections of the bar participate in these various vibrations. Thus, against all normal experience, *the resonant frequencies of the bar do not coincide with the frequency of the purely sinusoidal exciting oscillations.* Moreover, the form of the vibrations at the free end—nearly straight lines in all the previous cases—is very complicated (Fig. 12) and, for 30 and 45 degrees total twist, so irregular and violent that indicator traces cannot be obtained. Above resonance, the amplitudes diminish and the form of vibrations becomes once again purely sinusoidal.

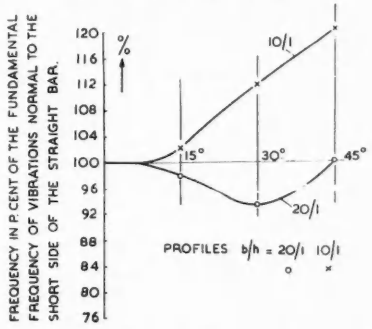


Fig. 11. **Change of fundamental frequency excited normally to short side h at the foot of twisted bars without taper, as a function of the total twist of free end relative to foot of bar.**

IV. EXPLANATION OF OBSERVED PHENOMENA

The cross-sectional moments of inertia about neutral axes parallel to the long side "b" at the foot of the bar increase with twist, i.e., with distance along the twisted bar (Figs. 1 & 2). The stiffness against, and thus the frequency of, vibrations normal to these neutral axes is thus higher for twisted bars than for straight bars. This effect is very slight for the lowest, fundamental, frequency (Fig. 3) since the upper, more highly twisted, part of the bar does not essentially contribute to the resistance against this form of bending vibrations. The slight angle between the directions of the vibrations at the head and the exciting oscillations (Fig. 4), moreover, indicates that the minimum moment of inertia for the mean direction of vibrations occurs, not at the foot of the bar, but slightly above it. If the very flat profiles show a slight decrease in fundamental frequency, this is still within the margin of inaccuracies. Deviations from the fundamental vibrations of the corresponding straight bar are therefore negligible. For the same reasons, one expects the first harmonic frequency of the squat bars (2/1, 4/1) to increase with the total twist (Fig. 5). The increase is more pronounced here, since the bending elasticity of the upper, stiffer, part of the bar is more important for the first harmonic than for the fundamental vibrations.

If, with increasing twist along the bar, the moments of inertia for vibrations excited normally to "b" at the foot are increased, those for vibrations excited normally to the short side "h" at the foot are generally reduced and the natural frequencies of these vibrations drop. If the profile is very flat (6·1/1 and over), the decrease may be so large that the fundamental frequency of the latter vibrations comes within the range of the first harmonic frequency of the former. The bar may then swing in a combination of both these natural vibrations, even if excited in one direction only (Figs. 5 and 7). The apparent node of the K_{II}-vibrations and the large angle of these vibrations at the free end (Fig. 6) prove that superposition actually takes place for flat profiles.

For a first approximation, assume that the flat bar with 45 degrees total twist swings at a mean direction of $\beta = 30$ degrees to the direction of excitation normal to "b" at the foot. The exciting amplitude in β-direction will be $a \cos 30$ when a = maximum deflection of exciting oscillations. The moment of inertia resisting the β-vibrations will vary along the bar in such a manner (Fig. 13) that the lower half of the bar is very stiff and substantially only the upper half vibrates noticeably with a fundamental frequency $\left(\frac{l}{l/2}\right)^2 = 4$ times that of vibrations extending over the entire bar. The β-vibrations of half the bar (a_I in Fig. 14) have again a cosine component in the direction of excitation. The amplitude in this latter direction is large at the free end, and an apparent node, or minimum of amplitude, exists somewhat below—because of the increasing stiffness of the free upper end—the point at which the first harmonic of the straight bar would have a real node. a_I therefore tends to produce a first harmonic (upper-node) vibration a_{II} acting over the whole bar, displaced

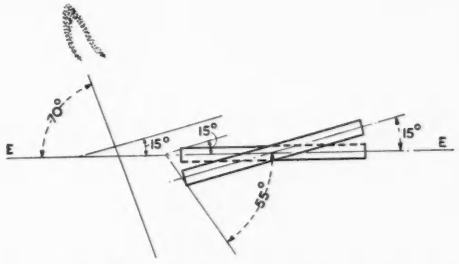


Fig. 12. **Form of vibrations copied from traces on indicator card (L.H. top, only slightly visible).**

Profile 20/1 with 15 degrees total twist. Excitation *EE* normal to short side h at the foot of the bar. The vibrations trace a complicated curve at an average angle of 70 degrees against *EE*.

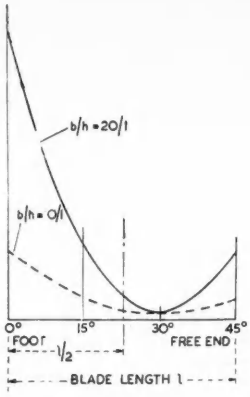


Fig. 13. **Axial moments of inertia, about the neutral axes normal to the mean direction of vibrations, of different rectangular cross-sections taken along flat bars having 45 degrees total twist of free end relative to foot. Mean direction of vibrations taken to be 30 degrees to the normal on the long side b at the foot of the bar.**

against β, and approximately in the direction of excitation. Because of the upper node, the a_{II}-amplitude at the free end must, except for the displacement, oppose the a_I-amplitude at the free end (see Fig. 14). If the a_I- and a_{II}-frequencies are roughly similar, the a_I-frequency may increase slightly, the a_{II}-frequency may decrease, and the two vibrations may then combine to a K_{II}-vibration. Calculations show that for the 20/1 profile, $a_I = 453$ per min. The first harmonic frequency of the straight bar would be 735 per min, but the corresponding a_{II}-vibration of the twisted bar (45 degrees) does not develop, as a_I and a_{II} combine to K_{II} with 562 per min frequency. For the 10/1 profile, the first harmonic frequency of the straight bar would be 1494, but a_{II} of the twisted bar (45 degrees) combines with a_I (1000 per min) to K_{II} with 1136 oscillations per min. Fig. 14 shows that at the free end of the 20/1 profile with 45 degrees total twist, the resulting K_{II}-vibrations must swing at about 60 degrees to the exciting oscillation, in rough agreement with experiment (Fig. 6). However, the assumption $\beta = 30$ degrees is only very approximate, and closer agreement might be obtained with $\beta = 35$ degrees.

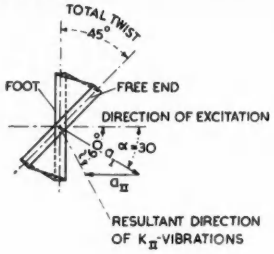


Fig. 14. **Resultant direction of K_{II}-vibrations of a flat profile.**

With a twisted bar of squat profile (2/1) the moments of inertia for β-vibrations do not vary appreciably along the bar, so that the half-bar fundamental vibration a_I cannot develop. For the entire bar, however, the first harmonic frequency is $(4{\cdot}694/1{\cdot}875)^2 = 6{\cdot}25$ times the fundamental frequency, and superposition becomes impossible.

The K_{III}-vibrations of flat profiles can be resolved similarly into a first harmonic vibration of the upper half and a second harmonic vibration of the entire bar (Figs. 9 and 10).

Excitation normal to the short side at the foot of a twisted bar produces first of all approximately the same high frequency as the corresponding fundamental vibrations of the straight bar, and the directions of excitation and of vibrations at the head will be but slightly displaced relative to each other. The increasing twist along the bar should reduce the relevant moments of inertia towards the free end and, therefore, also the frequency, but this hardly affects the fundamental cantilever vibrations. However, a flat profile may simultaneously vibrate in a definite oblique "γ-direction" normal to the long side (smallest moment of inertia) at the free end. If the total twist, although pronounced, is small (15 degrees), the moment of inertia for γ-vibrations increases but slowly from the free end; the γ-vibrations will, therefore, be effective over a greater length of the bar, and the γ-frequency lower, than where this moment of inertia increases more quickly (45 degrees total twist). If the γ-frequency falls within the range of the fundamental frequency excited normally to "h" at the foot of the bar and is able to combine with it, the combined frequency will also drop slightly with decreasing twist (Fig. 11).

V. VIBRATIONS OF TAPERED BARS

The fundamental frequency of twisted and tapered bars of flat profile deviates but little from that of the corresponding straight tapered bars. A taper in depth flattens a given profile and the deviation therefore remains negligibly small. A taper in width may increase the fundamental frequency of squat twisted bars (as observed on bars 16 mm in depth, 8·2 mm in width at the foot, and 7·3, 5·7, or 3·8 mm in width at the free end), but the deviation from the fundamental frequency of the straight tapered bar remains negligible. The direction of the vibrations at the free end changes slightly for strongly tapered bars, because the tapered end then forms a flat twisted profile tending to swing also in the γ-direction. Within the range of possible inaccuracies, the first harmonic frequencies of tapered and twisted bars again coincide with those of straight tapered bars. For twisted and tapered bars generally one can therefore safely adhere to the rules given for straight tapered bars (See footnote p. 115).

(a) Plot the cross-sectional areas as a function of the blade length and replace this curve by a straight line which fits the curve especially closely for the outer part of the blade length.

(b) Plot the relevant axial moments of inertia as a function of blade length, and replace this curve by a cubic curve which fits especially closely for the inner part of the blade length. Neglect local deviations and eliminate the reinforcements at the blade root by introducing a correspondingly reduced "effective blade length."

(c) The natural frequencies are then determined by

$$n = \frac{30}{\pi}\,\frac{\beta^2}{l^2}\,\sqrt{\frac{EI}{\rho A}}\ \text{per min},$$

where ρ = density of material. For the fundamental frequency, $\beta = 1{\cdot}875$, A to be taken from the straight line (a) at $e = 0{\cdot}231\,l$ distance from the blade tip, and l to be taken from the cubic curve (b) at $e = 0{\cdot}231\,l$ distance from the blade foot. For the first harmonic frequency, proceed similarly, taking $\beta = 4{\cdot}694$ and $e = 0{\cdot}431\,l$.

For the fundamental frequency, this method of calculation leads to results coinciding satisfactorily with values observed on propellers as well as turbine blades. For the first harmonic frequency, results are still satisfactory if the possible decrease due to twist (Fig. 5) is considered separately.

Change Wheel Gearing

By O. LICHTWITZ, M.I.MECH.E.

(*Continued from March issue*).

CHAPTER IV

CONSIDERATIONS OF STRENGTH

The forces which are transmitted by the change gears depend primarily on the work to be done, and it can be assumed that the pitch and width were correspondingly determined by the designer of the machine. However, it is the operator's concern to use the gears in such a way as to reduce the load as far as possible. Even if the load is permissible, and there is no danger of breaking the teeth, this precaution is advisable, as, with reduced loads, wear is also reduced, and the gears transmit the motion more exactly.

(*a*) *Two-Gear Trains*

If the same driven shaft torque is transmitted by gears of different diameters, the load on the teeth is inversely proportional to the diameter, or the larger the gear the smaller the load on its teeth. As the load is the same for both meshing gears, the load on the teeth of the driving gear is reduced at the same time.

Gears, therefore, should be chosen as large as possible. The gear trains 60/90 and 20/30 are equivalent, but in the former case the stress is reduced to one third.

(*b*) *Four-Gear Trains*

Here again the gear on the driven shaft should be as large as possible. Similar considerations lead to the advisability of a large gear also on the driving shaft. The loads of the gears on the stud are the same as those of the gears with which they mesh, independently of their size; therefore, they need not be large.

Example 10. Required ratio 4/13; gears with 20 to 120 teeth, in steps of 5, are available.

The simple gear train 20/65 can be applied. By using the equivalent compound train $(80\times 30)/(65\times 120)$, however, with the gear 80 on the driving shaft, and 120 on the driven shaft, the load on the driving gear is reduced to $20/80 = 25$ per cent, and the load on the driven gear to $65/120 = 54$ per cent.

Example 10 shows that a higher gear train than absolutely necessary can be a means of keeping the stress on the gears small. The accuracy of transmission is, in the case of four-gear trains, only slightly less than in the case of two-gear trains, as the latter also usually require an intermediate gear on a stud.

The notation of a gear train as $(80 \times 30)/(65 \times 120)$ will subsequently mean a gear train where the gear 80 is the first driver and 30 the second, and 65 the first driven gear and 120 the second. The order indicated, that is, driving gears descending and driven gears ascending, ensures small loads on the teeth; that arrangement applies both to ratios smaller and to ratios larger than 1.

(*c*) *Six-Gear Trains*

Let the torque of the driven shaft be denoted by T and the ratio between the speeds of driven and driving shaft by r.

Let a denote the radius of the first driving gear in Fig. 4*, and A the load transmitted by the teeth; analogous notations are chosen for the other gears. If losses in the transmission are neglected, the torque to be transmitted by the driving shaft is rT, and the load $A = rT/a$.

The same load is transmitted by the first driven gear, and $B = rT/a$.

The load of the second driving gear is

$$C = \frac{b}{c}B = \frac{b}{c}\,\frac{1}{a}\,r\,T.$$

In determining the loads of the 3 other gears, it is simpler to start from the driven shaft. The loads of the third driven and driving gear are found similarly as above, $F = T/f$, and $E = T/f$.

The load of the second driven gear is $D = \frac{e}{d}\,\frac{1}{f}\,T$.

(By inserting $r = \frac{a}{b}\,\frac{c}{d}\,\frac{e}{f}$ it will be found that $D = C$)

The conditions for keeping the loads small are:

a must be large (compare the formula for load A)
ac „ „ „ („ „ „ „ „ C)
e „ „ small („ „ „ „ „ D)

This means that we must aim at obtaining the first two driving gears large, and the last small; by considering the loads A and C it will be found that the largest gear should be the first driver. The gears are, therefore, to be used in descending order, both for $r < 1$ and $r > 1$.

Similar considerations show that the driven gears are to be used in ascending order.

Subsequently a notation such as $\frac{53\times 51\times 23}{28\times 37\times 60}$ means a gear train where the gears 53, 51, 23 are the first, second, and third drivers, and 28, 37, 60 the first, second, and third driven gears respectively.

Example 11. The ratio $\frac{17\times 23\times 31}{19\times 29\times 39}$ was computed; gears from 20 to 60 available.

17 and 19 are best multiplied by 3, 23 and 29 by 2.

Then $\frac{17\times 23\times 31}{19\times 29\times 39} = \frac{51\times 46\times 31}{57\times 58\times 39}$, and the proper order is $\frac{51\times 46\times 31}{39\times 57\times 58}$.

CHAPTER V

THE MOUNTING OF CHANGE GEARS

PROBABLY everybody who has dealt with change gears has experienced cases where a gear train could not be assembled; either the gears were too small and did not bridge the distance between the shafts to be connected, or they were too large and interfered with each other or another part of the machine.

These difficulties can be avoided by a proper arrangement of the gears. Anticipating the result of the following considerations, the arrangement which was found in Chapter IV as advantageous from the aspect of strength is also a means for avoiding interference.

(*a*) *Two-Gear Trains*

The driving and driven gears (Fig. 15) do not mesh directly with each other but do so through an idler. The distance δ of the centres A B and the (diametral) pitch P of the gears should be known to the person who computes the change gears.

a may denote the number of teeth in the driving gear, and similarly b and i those of the driven gear and idler.

As the pitch diameter of a gear with n teeth is n/P, and the outer diameter $(n + 2)/P$ the condition that driving and driven gears do not mesh is $a+b < 2\,\delta\,P$—4. (Here the addendum of the teeth is as usual $1/P$).

The sum of the distances A C and B C must exceed the distance δ, or $a + b + 2c > 2\delta P$.

* See January issue, p. 8.

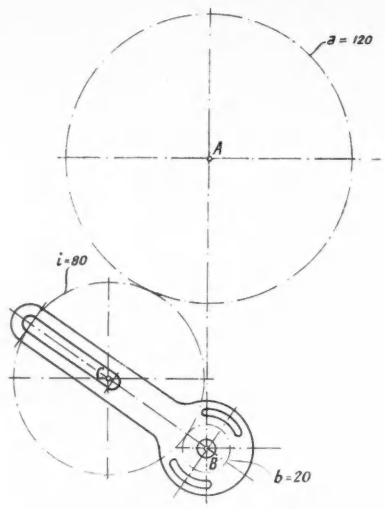


Fig. 15. **Mounted gear train** $\frac{120}{20}$

Example 12. Centre distance $\delta = 9\frac{1}{2}$ in.; diametral pitch $P = 12$; required ratio $r = 11/12$; change gears available from 20 to 120 in steps of 5, the gear 20 in duplicate.

Both the gear trains 55/60 and 110/120 are equivalent to 11/12. With $2\,\delta\,P = 2 \times 9\frac{1}{2} \times 12 = 228$, one condition is $a + b < 228 - 4 = 224$.

That excludes the gear train 110/120 as $110 + 120 = 230$.

The other condition is $a + b + 2c > 228$.

For $a + b = 55 + 60 = 115$, it is found that $2c > 228 - 115 = 113$, or $c > 56\frac{1}{2}$.

This indicates that any gear with at least 65 teeth is suitable as idler (the nearest gear to $56\frac{1}{2}$ is 60 but it is used as a driven gear).

(*b*) *Four-Gear Trains*

Fig. 3 shows a four-gear train; a small gear is often used as a distance piece which can be replaced by a washer, smaller still. That gear must not mesh with the second driving gear, and similarly the lock nut must not interfere with the first driven gear.

The condition that the distance piece should not mesh with the second driving gear is $a + b > a' + c + 4$.

If $a > c$ (i.e., the first driver larger than the second), and if $a' < b - 4$ (i.e., the gear used as distance piece has at least 4 teeth less than the first driven gear), the above condition is fulfilled.

In the case of two-gear trains, generally the only risk is that the gears are too large; small gears do not involve difficulties because a sufficiently large gear can serve as intermediate gear.

In the case of four-gear trains it is just the reverse. As distance piece and lock nut (Fig. 3) can be kept sufficiently small, large gears do not involve difficulties. Because, however, the gears on the stud are not chosen arbitrarily, there is a possibility that the gears do not bridge the distance between driving and driven shaft.

Similarly as for two-gear trains, it is found here that $a + b + c + d > 2\,\delta\,P$ (Fig. 16).

It is hardly ever the case that the distance δ is so small that there is a risk of interference between distance piece and second driven gear, or between first driving gear and lock nut; the conditions $(d + a') < 2\,\delta\,P - 4$, and $(a + d') < 2\,P - 4$ will always be fulfilled.

Example 13. The ratio $r = 5/39$ is required on the same machine as assumed in Example 12.

As a two-gear train cannot be formed, several four-gear trains come into consideration, e.g., $(25\times 20)/(60\times 65)$, or $(40\times 25)/(65\times 120)$, or $(50\times 20)/(65\times 120)$; the sum of all 4 gears is 170, 250, and 255 respectively.

As 170 is less than the minimum of 228 teeth, the first train cannot be realized; $(50\times 20)/(65\times 120)$ is preferable to $(40\times 25)/(65\times 120)$ as a larger gear is placed on the driving shaft.

A distance piece with $a' = 20$ teeth does not interfere with the second driven gear as $d + a' = 120 + 20 = 140$ is well below 224.

(*c*) *Six-Gear Trains*

Mounting a four-gear train is as easy as mounting a two-gear train. Six-gear trains involve many difficulties, and are often impracticable because of frequently unnecessary restrictions due to the design of the machine.

The difficulties arise from the fact that the three pairs of gears are arranged in two planes (Fig. 4); an arrangement in three planes would lead to the simplicity of four-gear trains.

The length of the broken line joining the centres *A*, *B*, *C*, *D* (Figs. 17 and 18) must exceed the distance $\delta = AB$, or $a + b + c + d + e + f > 2\,\delta\,P$.

As in the case of four-gear trains, an interference between the lock nut on the driving shaft, and the second driving gear is avoided if $a > c$; for similar reasons an interference between the lock nut on the driven shaft and the second driven gear is avoided if $f > d$.

If $c > e$, and $d > b$, then $c + d > b + e$, so that interference between first driven and third driving gear is unlikely.

Therefore, the arrangement recommended from the point of view of strength, avoids interference between the lock nut on the driving shaft and the second driving gear, between the lock nut on the driven shaft and the second driven gear, and between first driven and third driving gear; the latter, however, only if the difference between $(c + d)$ and $(b + e)$ is at least 4.

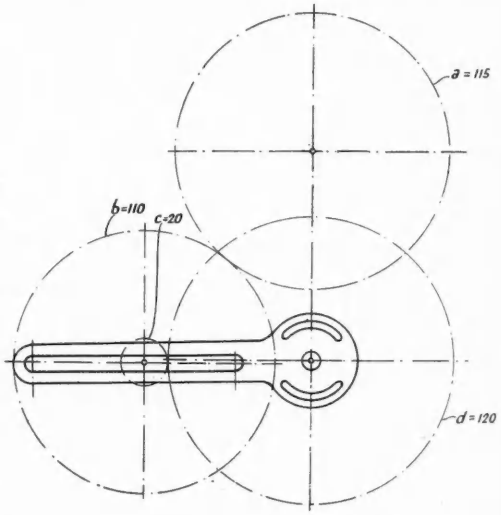


Fig. 16. **Mounted gear train** $\frac{115\times 20}{110\times 120}$

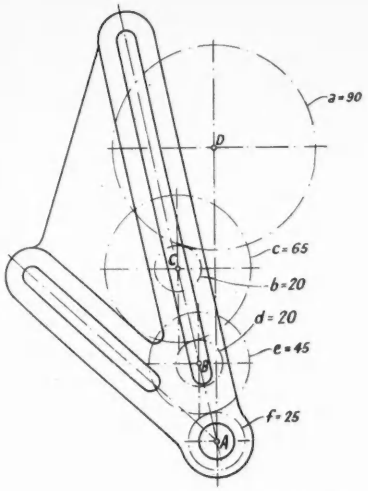


Fig. 17. **Mounted gear train** $\frac{90\times 65\times 45}{20\times 20\times 25}$

A gear train such as $\frac{53\times 53\times 53}{59\times 59\times 59}$ cannot be mounted because there is no difference at all between $(c + d)$ and $(b + e)$. Such cases are also possible in trains consisting of 6 different gears (e.g., $\frac{53\times 23\times 22}{29\times 31\times 59}$ where interference occurs by any arrangement of the gears); they are, however, hardly to be expected. The probability is higher for trains with two or three equal gears; these trains would probably be impracticable, because the gears are seldom available in duplicate or triplicate.

The arrangement, driving gears descending, driven gears ascending, is thus only a guarantee of no interference if the broken line connecting the centres *A*, *B*, *C*, *D* (Figs. 17 and 18) is not far from the straight line connecting *A* and *D*; otherwise there may easily be interference between first and third driving gear, or first driving and third driven gear.

Fig. 17 shows a gear train where the centres *A*, *B*, *C*, *D* are almost aligned, and where there is no risk of interference. Fig. 18 shows a gear train where the centres *A*, *B*, *C*, *D* form a strongly marked quadrangle. There is no interference, but it will be appreciated that the first and third driving gears, and the first driving and third driven gear come very close to each other.

It is difficult to determine by calculation whether a six-gear train can be mounted or not, and it is simpler to try it in practice. If it is possible to choose a gear train for which the sum of all numbers of teeth is not far from the minimum stated above, no difficulties will be encountered in mounting.

Example 14. The ratio $r = 3/49$ is required on the same machine as assumed in Examples 12 and 13.

There is no possible four-gear train for 3/49, but it can be expressed by six-gear trains as follows: $\frac{30\times 20\times 20}{35\times 70\times 80}$, or $\frac{90\times 30\times 20}{70\times 105\times 120}$; the sum of all gears is 255 and 435 respectively, thus larger than 228, and both gear trains are possible.

As 255 is fairly close to 228, the centres of all gears will be nearly in line, and no interference need be

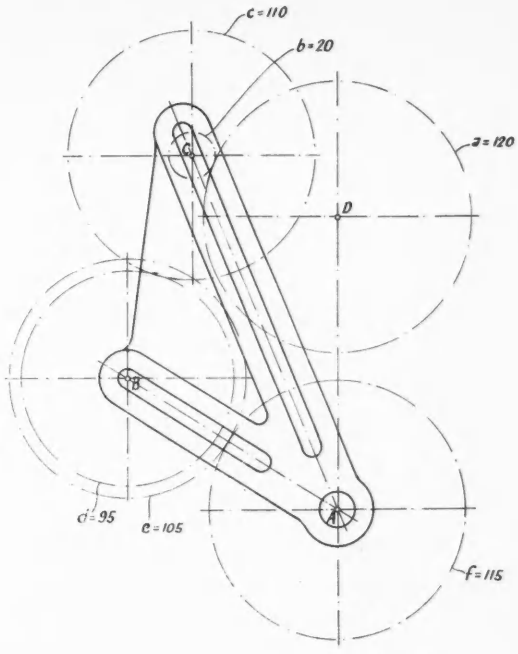


Fig. 18. **Mounted gear train** $\frac{120\times 110\times 105}{20\times 95\times 115}$

feared for the gear train $\frac{30\times 20\times 20}{35\times 70\times 80}$. It depends on the design of the machine whether or not the gear train $\frac{90\times 30\times 20}{70\times 105\times 120}$ can be mounted.

Chapter VI

CHANGE GEARS SERVING TWO PURPOSES

When cutting multiple threads in a lathe, the change gears, in addition to providing the proper ratio between the movement of spindle and lead screw, also have to serve for indexing. A gear is usually placed on the spindle stud, which has a number of teeth divisible by the number of required starts. This gear is disengaged from its mating gear, and rotated through an appropriate angle, while the tool position remains unchanged.

Example 15. A two-start thread is to be cut; the gear train is $(90\times 35)/(85\times 95)$.

After the first thread is finished, the gears 90 and 85 are disengaged, and the gear 90, together with the work spindle, is rotated through half a revolution; this is carried out by rotating the gear on the spindle stud $90/2 = 45$ teeth farther. The gears 90 and 85 are then re-engaged.

The simple manipulation described in Example 15 is possible if the number of teeth of the gear on the spindle stud (90) is a multiple of the number to be indexed (2).

If the gear train for a two-start thread is $(105\times 65)/(20\times 120)$, it is better to replace it by $(70\times 65)/(20\times 80)$. The load on the teeth would be increased, but the gear 70 would enable indexing of 2. However, there are often gear trains which cannot be replaced exactly by others, except by interchanging the order of the gears.

Example 16. A three-start thread is to be cut; the gear train is $(85\times 75)/(95\times 110)$.

85 is not divisible by 3, and there is no other equivalent gear train. If the driving gears are interchanged to the gear train $(75\times 85)/(95\times 110)$ the gear 75 on the spindle stud renders the task possible.

The driving gears can be interchanged only if they are near to each other in size (75 and 85 in Example 16); in this case, there is no risk of interference. However, in a gear train such as $(115\times 20)/(85\times 90)$, an attempt to use the gear 20 as the first driver will fail because the large gear 115 would interfere with another part of the machine.

Example 17. A two-start thread is to be cut; the gear train is $(115\times 20)/(85\times 90)$.

Although the gear 20 cannot be used as first driver, it enables rotating the work 180 degrees while the tool remains unchanged. Gears 20 and 90 are disengaged, not 115 and 85. As one revolution of the combined gears 20 and 85 effects 85/115 revolutions of the spindle, 115/2 revolutions of the gears on the stud impart to the spindle $(85/115)\times(115/2) = 85/2 = 42\frac{1}{2}$ revolutions; $115/2 = 57\frac{1}{2}$ revolutions can easily be imparted to the gear 20, by making 57 full turns plus a movement corresponding to 10 teeth; $42\frac{1}{2}$ revolutions of the spindle bring the work into the required position.

The method demonstrated in Example 17 necessitates making several additional turns to the work; it can be applied if any driving gear is divisible by the number to be indexed. If the second driver is used for indexing, the number of turns imparted to it is, generally, the number of teeth of the first driver divided by the number to be indexed.

Indexing can be performed in the same way as in Example 17, if neither driving gear alone is divisible by the number of starts, but if their product is divisible by it.

Example 18. A six-start thread is to be cut; the gear train is $(100\times 75)/(55\times 65)$.

Neither 100 nor 75 is divisible by 6; the former is divisible by 2, and the latter by 3, so that the product of both is divisible by 6.

Here again the second driver is used for indexing. As one revolution of the gears on the stud corresponds to 55/100 revolutions of the spindle, $100/6 = 16\frac{4}{6}$ revolutions (corresponding to the rule above), that is, 16 full turns plus 50 teeth of the gear 75, correspond to $(55/100)\times(100/6) = 55/6 = 9\frac{1}{6}$ turns of the spindle.

In Example 18, the second driven gear (65) is inactive during the indexing operation. The ratio $\dfrac{\text{product of driving gears}}{\text{active driven gear}} = \dfrac{100\times 75}{55}$, reduced to its lowest terms 1500/11, has still a numerator divisible by the number of starts (6). In Example 17, the ratio $(115\times 20)/85 = 460/17$ is similarly divisible by 2. It will be shown that this feature is a condition for indexing.

Example 19. A four-start thread is to be cut; the gear train is $(50\times 30)/(70\times 80)$.

The product of the numbers of teeth of the driving gears (50×30) is divisible by 4, but $150/7 = (50\times 30)/70$ has a numerator which is not divisible by 4.

As one revolution of the gears on the stud effects 70/50 revolutions of the spindle, 50/4 revolutions effect $(70/50)\times(50/4) = 17\frac{1}{2}$ revolutions of the spindle, which is suitable for indexing of 2, but not of 4.

If the two driven gears are of similar size, they can be interchanged, thus enabling in some cases indexing of a number which otherwise is not obtainable.

Example 20. A four-start thread is to be cut; the gear train is $(110\times 90)/(20\times 25)$.

The product (110×90) is divisible by 4. If 20 is used as the first driven gear, indexing cannot be performed as $495/1 = (110\times 90)/20$ has a numerator which is not divisible by 4. (In this case, gear 25 is not used for indexing.)

The arrangement $\dfrac{110\times 90}{25\times 20}$, however, renders the task possible, as $396/1 = (110\times 90)/25$ has a numerator divisible by 4. Interchanging of the driven gears which only slightly differ in size is possible.

The previous examples show that indexing can be carried out in many cases by a departure from the recommended arrangement of the gears. Nevertheless, there may be cases where neither arrangement is suitable. If a slight error in the ratio is permissible, a substitute ratio can be found as demonstrated in Chapter III.

Example 21. A two-start thread is to be cut; the gear train is $\dfrac{65\times 55}{105\times 115}$; gears from 20 to 120 in steps of 5 are available. The exact ratio is $\dfrac{65\times 55}{105\times 115} = \dfrac{13\times 11}{21\times 23}$ $= 143/483$. The available gears give the same results as gears with all numbers of teeth from 4 to 24, so that the highest available number for a substitute gear train is $23\times 24 = 552$.

It will be found that the best approximation is $\dfrac{45}{152} = \dfrac{9\times 5}{8\times 19} = \dfrac{90\times 25}{80\times 95}$, with an error of less than 1 in 20,000. Indexing is performed with the gear 90 as first driver.

Six-gear trains are mostly used for obtaining a pitch which is so small that it cannot be obtained by a four-gear train, and it is improbable that a multiple-start thread would have such a small lead. Six-gear trains, however, are also a means for avoiding four-gear trains unsuitable for indexing.

Example 22. Six-gear trains are possible; gears from 20 to 120 are available in steps of 5; Examples 19 and 21 are to be reconsidered.

(a) $\dfrac{50\times 30}{70\times 80} = \dfrac{120\times 45\times 25}{60\times 80\times 105}$. The gear 120 on the driving shaft renders indexing of 4 possible.

(b) $\dfrac{65\times 55}{105\times 115} = \dfrac{80\times 65\times 55}{70\times 115\times 120}$. The gear 80 on the driving shaft renders indexing of 2 possible.

In both cases of Example 22 there is a suitable gear as first driver. Indexing can sometimes be performed by means of a suitable driving gear on the first or second stud; the calculations are analogous to those of four-gear trains.

Example 23. A three-start thread is to be cut; the gear train is $(115\times 85)/(65\times 105)$.

The gear train can be transformed into $\dfrac{115\times 85\times 60}{65\times 70\times 90}$. Indexing is carried out by disengaging the gears 60 and 90. The quotient of the driving and driven gears used is $\dfrac{115\times 85\times 60}{65\times 70} = \dfrac{115\times 17\times 6}{13\times 7}$ which is divisible by 3.

The first two drivers may be imagined as replaced by an effective gear $115\times 85 = 9775$, and the first two driven gears by an effective gear $65\times 70 = 4550$. The gear train is then $(9775\times 60)/(4550\times 90)$.

As in Example 17, during 9775 revolutions of the combined gears 4550 and 60, the driving shaft makes

(*Continued on page* 152)

Deformable Gas Vessels as Protective Equipment for Power Transformers

By H. Josse. (From *Bulletin de la Société Française des Electriciens*, Vol. 10, 6th Series, No. 100, January, 1950, pp. 41-46, 2 illustrations.)

In all oil-immersed transformers so far built, the atmosphere has access to the insulating oil. From this, two difficulties arise, namely, progressive oxidisation and progressive humidification of the oil, the latter leading, in turn, to humidification of the insulating materials used in the transformer. These facts are well known and so are their bad operational consequences.

Access of the atmosphere to the insulating oil can be prevented by filling the space of the tank, or the oil conservator, above the oil level with nitrogen gas. Although this method has been generally known and recognised for a long time, it was not adopted by designers for industrial purposes until recently.

Experiments carried out in 1943 and 1944 showed that this system could be used economically for industrial applications, but only if the consumption of nitrogen gas was very low; this led to the idea of applying the nitrogen at only slightly more than atmospheric pressure. This was achieved by inserting deformable rubber containers between the nitrogen bottle and the transformer (Fig. 1), these containers thus acting as "separating membranes" between the nitrogen and the atmosphere. By this means, the gas pressure can be maintained at a level only slightly above atmospheric, so that only minute quantities of nitrogen escape. Another advantage of this system is that in the case of transformers having on-load tap-changing gear, the board separating the gear from the main part of the tank is not subjected to excessive stresses, and that the transformer, including the tank, need not be designed for a higher pressure than is customary.

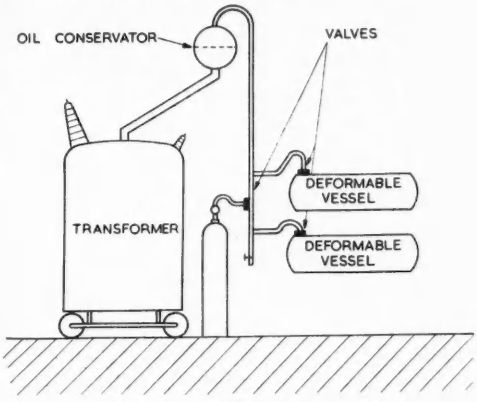


Fig. 1

An added advantage is that the equipment can be installed on existing as well as new transformers without any modifications; it can be produced at low cost, and Buchholz protection can be used in the ordinary way. It also allows the use of more expensive gases than nitrogen, without noticeably increasing the cost of operation. The method can be used for measuring as well as power transformers.

The constructional arrangements differ according to the type of transformer, in conjunction with which the equipment is to be used, and according to the lay-out of the substation. In the case of power transformers with a conservator of 1 to 4 m^3 capacity, it is convenient to house the rubber containers in small metal or concrete cubicles as close as possible to the transformer.

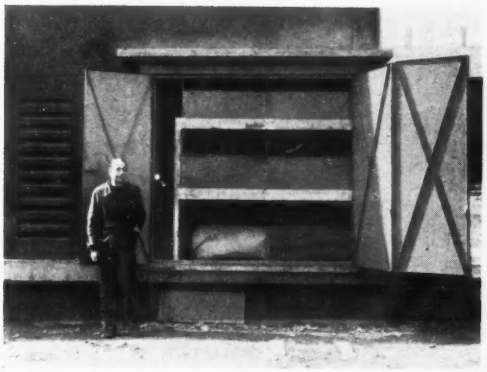


Fig. 2

These cubicles contain 2 to 3 shelves separated by about 80 cm in height, where the rubber containers, connected in parallel, can be deposited. Fig. 2 shows such an arrangement for a 36000-kVA transformer; the cubicle is built on to the wall of the transformer bay. The containers are connected to the transformer by metal tubes of 2 to 3 cm bore. The containers themselves are cylindrical, and have a diameter of 60 to 100 cm. The thickness of the rubber is about 1·2 to 1·5 mm, and may be up to 2 mm for very large sizes. As a rule, rubber as used for the inner tubes of tyres is satisfactory for this purpose, but where it is affected by oil vapours, oil-resistant rubber should be used.

The whole arrangement can be installed easily and maintained by the transformer maintenance personnel. There are, however, a few points which should be mentioned. Firstly, great care must be taken to ensure that all joints of the oil conservator are air-tight. Secondly, the metal tube connecting the oil conservator to the rubber containers should lead from the highest point of the conservator straight to the containers without forming "lowest points." Thirdly, if more rubber vessels than one are used, each vessel should be linked to the metal tube by a separate rubber tube of about 8 mm bore.

The cubicle housing the rubber vessels should also house the high-pressure nitrogen bottle, where this is required, together with the pressure-reducing valve. The shelves of the cubicles should be covered with polished wood so as to avoid fatigue and sticking of the rubber. To retard ageing of the rubber vessels, the cubicle must be made light-tight.

Experience has shown that in medium-size installations, it is not necessary to provide a permanently connected high-pressure bottle, as the nitrogen losses are so small that it is sufficient periodically to inflate the rubber vessels.

The first operational experiments with the equipment described were made on a single-phase, 2400 kVA, 60000/3000 V transformer at Saint Denis power station in Paris in 1948 and 1949. The oil conservator of this transformer had a capacity of 350 litres and the rubber vessel, of 1·5 mm wall thickness, was of the same capacity. It was found that only very small quantities of nitrogen escaped and that one filling lasted about six months. Oil insulation tests were carried out periodically and no deterioration was noticed during the 15 months the experiments lasted. Another series

of experiments, on a 12000 kVA, 60000 V transformer is at present being carried out. The capacity of the oil conservator of this transformer is 1500 litres. Three rubber cylinders of a total capacity of 1680 litres are used for the nitrogen. They are 60 cm in diameter and 2 m in length, and are made of rubber 2 mm in thickness.

The maintenance of this equipment is simple. The man in charge has merely to check whether nothing obviously abnormal has occurred, whether the transformer and the nitrogen equipment are air-tight, and whether the pressure is adequate. If the nitrogen pressure has dropped, he has only to re-inflate the cylinders from the nitrogen bottle.

The advantages obtained by using this equipment are briefly as follows: The maintenance of the transformer is reduced to checking the degree of inflation of the rubber vessels; it is no longer necessary to carry out dielectric tests of the insulating oil every six months, or to make chemical tests every two years; oil treatment, normally carried out every two years, will only need to be carried out at much longer intervals, probably about every 10 years; and the risk of transformer faults due to the deterioration of the insulating oil will be considerably reduced. In the long run, all this will mean an increase in the expected useful life of transformers so protected, besides a practically indefinite life of the insulating oil.

BELGIUM

The Oxy-Kinetic Flame Cutting Process

By A.-E. LEDUC. (From *L'Ossature Métallique*, Vol. 15, No. 1, January, 1950, pp. 37-41, 11 illustrations.)

STAINLESS steel is difficult to flame-cut. The slag is highly viscous, sticks to the cutting edge, and the oxygen jet alone cannot expel it. Several processes attempt to liquefy the slag by injection of chemicals or reacting metal particles. The process described here, however, consists in charging the jet of oxygen with solid particles, thus strongly increasing its kinetic energy, and in expelling the slag by purely mechanical action. Favourable test results have been obtained with 18-8 stainless steels and special steels of still higher alloy content, as well as with cast iron.

The complete plant is shown schematically in Fig. 1. From a hopper, the particles fall through a regulating valve into a small receiver, where the stream of oxygen picks them up. The great speed of the oxygen accelerates the flow of the particles until they leave the burner at a high velocity. The burner itself resembles the ordinary flame-cutting burner, except that a special nozzle has been introduced to withstand the abrasive action of the particles. The operation is the same as for the normal flame-cutting process: first priming and heating up, then cutting with the high-pressure jet charged with particles. The burner may be moved by hand or automatically. Several, even thick, plates can be stacked on top of each other and cut simultaneously; even if warped, they need not be clamped together. The particles must resist shock and must not disintegrate under the combined effect of shock and temperature; moreover, they must pass in a continuous and regular stream through the small orifice of the burner. Sand is a good material for these requirements, but it must be homogeneous, carefully sifted for uniform grain size, and uncontaminated with dust or foreign matter. A long and painstaking treatment of the sand is therefore required.

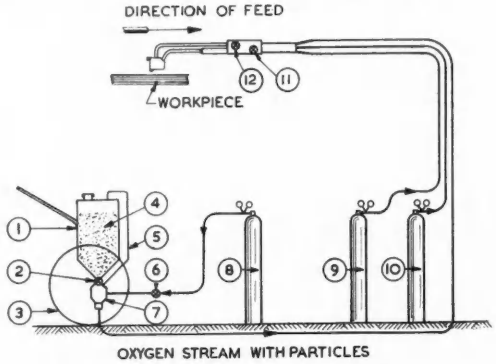


Fig. 1. **Schematic arrangement of plant for oxy-kinetic flame-cutting.**

(1) Hopper; (2) regulating valve for dosage of particles; (3) wheels; (4) particles; (5) pipe equalising the air pressure in dosage receiver and hopper; (6) regulating valve for cutting oxygen; (7) receiver for injection of particles into the oxygen stream; (8) oxygen bottle for cutting oxygen; (9) oxygen bottle for pre-heating; (10) acetylene bottle for pre-heating; (11) regulating valve for oxygen used for pre-heating; (12) regulating valve for acetylene used for pre-heating.

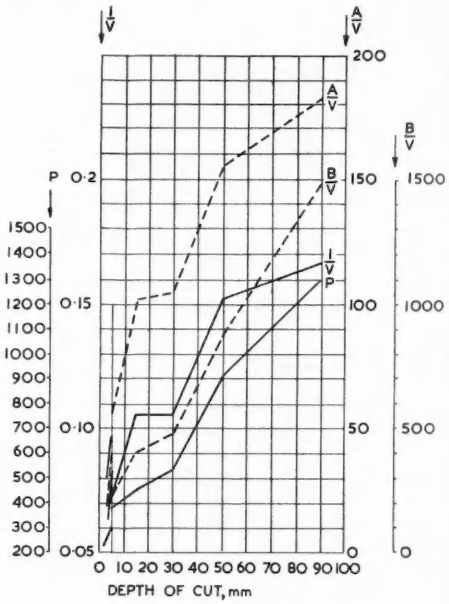


Fig. 2. **Oxy-kinetic cutting (Cinox) of 18-8 stainless steel.**

V = cutting speed in m/hr; A/V = acetylene consumption in litres per metre of cut; B/V = total oxygen consumption in litres per metre of cut; P = consumption of particles in grams per metre of cut.

0·1 hour per metre = 1·8 minutes per foot of cut.
1000 grams per metre = 11 ozs. per foot of cut.
100 litres per metre = 1·1 cubic feet per foot of cut.
1000 litres per metre = 11 cubic feet per foot of cut.

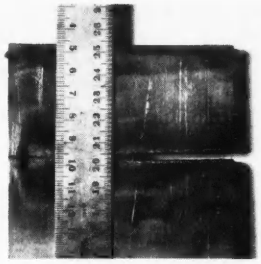


Fig. 3. **Cut in stainless steel plate of $^5/_8$ in. thickness.**

Results on Stainless Steel

The oxy-kinetic process produces clean cutting edges and narrow cuts without cutting fringes at the top or bottom (Fig. 3). A rapid and economic cut is obtained (see Fig. 2). In 18-8 steels, stabilised by additions of niobium or titanium, a change in grain structure can be observed directly at the cutting edge, but it does not extend to a depth greater than 0·024 to 0·04 in. The Brinell hardness of such a steel drops from 200 in the unaffected metal to about 140 at the cutting edge, so that the machining of a flame-cut edge is greatly simplified. The edge need not be ground, but can be planed, shaped, or milled. Stainless steels which are not stabilised undergo a change in grain structure near the cutting edge and will be less resistant to corrosion at these faces. A water jet can, therefore, be arranged to follow immediately behind the cutting jet, so that the material is quenched and regains its initial austenitic structure. The local modification of the structure, however, is usually not very important, especially if the metal is welded after cutting. Industrial cuts have been taken on stainless steel plate up to 8 inches in thickness, yet this is not the maximum thickness that can be cut.

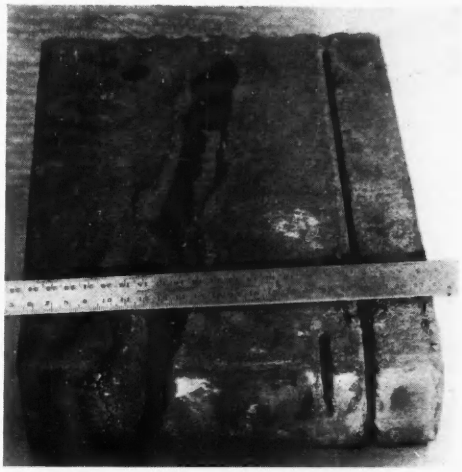


Fig. 4. **Cuts in cast iron plate of $1\frac{1}{16}$ in. thickness.**
Left cut taken with ordinary burner for cast iron, right cut taken with oxy-kinetic process " Cinox."

Results on Cast Iron

Even here, the oxy-kinetic cutting process gives a clean narrow cut, whilst the usual high-temperature burner leaves a wide, irregular groove in the metal (Fig. 4). The economic advantage of the new process is, therefore, very pronounced. The cut edge is not as smooth as with stainless steels, but its appearance is remarkably regular, with only a small fringing effect at the top of the cut. Changes in the grain structure of the material are again localised and do not penetrate further than 0·04 inch into the material. Castings of 8 inches wall thickness have been successfully cut, and again, this is not the maximum of which this process is capable.

GERMANY

Heat Reflecting Paints

By F. HOFFMANN, Wuppertal-Barmen. (From the Archives of the Board of Trade, London.)

THIS paper describes the results of investigations into the reflectivity of various paints. These investigations were undertaken because the heat reflectivity was found to be of major importance for :

(1) Precision measuring instruments, the accuracy of which is adversely affected by temperature variations due to solar radiation ;
(2) Fuel tanks, as heating through solar radiation considerably increases evaporation losses in stationary as well as mobile (railway, etc.) tanks ;
(3) Beverage containers, refrigerator and cold storage wagons, etc., the contents of which are liable to be spoiled through irradiation ;
(4) Vehicles, particularly motor vehicles, used in hot climates, where solar radiation is liable to cause extreme discomfort to the occupants.

The investigations are a sequel to work on infra-red camouflage paints, and the following arrangement was used for measuring the heating effects of infra-red rays. In the case of paints, light metal plate 10 × 20 mm in size were painted and inserted in the measuring apparatus. In the case of pigments, a suitable small flat container was filled to a depth of 3 mm with the pigment under investigation, and a uniformly smooth surface was obtained by compression. These samples were

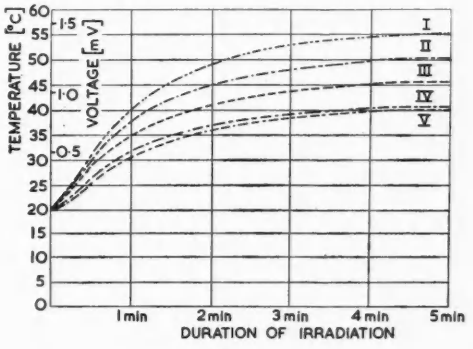


Fig. 1.

irradiated through condensers by the concentrated radiation of fifteen 30-W incandescent lamps. This was thought to be approximately equivalent to direct solar radiation. The lamp current was kept strictly constant. To avoid any heat losses from the test specimens, the latter were heat-insulated with asbestos.

The temperature was measured by means of iron-constantan thermo-couples, which possess a relatively high thermo- e.m.f. As a result, the heat-receptive part of the general arrangement was the test specimen itself, plus the practically negligible mass of the thermo-couple. The latter was pressed against the back of the test specimen by a small spring.

Test results shown in Fig. 1 permit of making a comparison between a black paint (I), an average paint (II), and a paint favourable for the reflection of infra-red radiation (IV, V). The same measurements also proved that, above all, the pigments were favourable for the reflection of infra-red radiation; subsequent investigations were, therefore, concentrated on pigments.

It must be pointed out at this juncture that, in principle, differences due to binders are only small and generally exist only between film-forming and emulsion binders. Emulsion paints always show a higher reflectivity than film formers, but as, in practice, film-forming coatings merit preference due to their higher mechanical and corrosion resistance, subsequent investigations were carried out with one and the same film-forming binder.

As it was found that the behaviour of the pigments solely in the infra-red range is of importance for the evaluation of the test results, curves were first of all plotted which showed the reflected light energy as a function of the wavelength. Fig. 2 shows a number of curves for various pigments. Curves 5 and 6 offer the most interesting data, as they indicate the values obtainable in practice.

As it is not possible to use pure white or yellow-white coats under certain conditions, particularly in war-time, the possibility of using two-layer coats in such cases was also investigated. It was found that good results can be obtained if an isolating coat of a reflective pigment is placed between the camouflage coat, or coats, and the metallic body.

Systematic investigations in this direction showed that the isolating coat should contain well crystallised pigments, besides pigments with a high content of white. As, in practice, materials consisting of quartz powder, sodium chloride, and similar crystallised materials cannot be used, a special study was made of inorganic pigments. It was found that, in practice, mixtures of white pigments with inorganic yellow gave the best isolating layers.

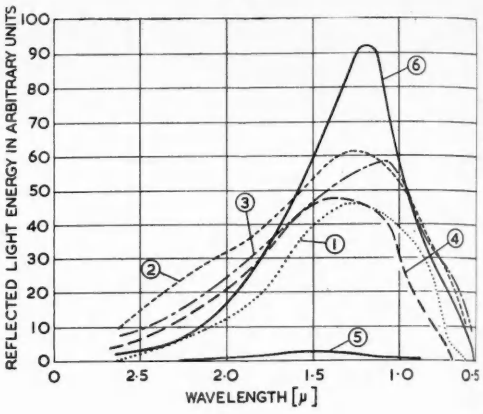


Fig. 2.

(1) Chrome green; (2) Hansa yellow; (3) white pigment; (4) ultramarine blue; (5) carbon black; (6) inorganic yellow.

The problem of determining the most favourable camouflage paint in this connection led to the fortunate finding that—except for a few entirely unsuitable colours like carbon black, Berlin blue and dark ochre—the top coats had practically no adverse influence on the heat reflectivity of the isolating first coat. Likewise, the thickness of the top coats had only a relatively small influence. Nevertheless, it seems of advantage to use for the top coats paints of highest possible transparency, i.e., colours such as chrome green, iron oxide red, various nitro green colours, and Hansa yellow.

The investigations described show clearly that even with the most unfavourable camouflage paints, an isolating layer can substantially restrict the temperature increase of the metal body due to heat radiation. Parallel experiments have shown that, as compared with camouflage paints without an isolating coat, reductions in temperature from +55° C to +38° C, i.e., by 17° C, were obtained, using average camouflage as the top coat; by careful selection of the top coat, this temperature was even reduced to +32° C.

U.S.A.

Hot Spot Machining at Work Temperatures of 500°, 1000° and 1500° F.

By S. Tour and L. S. Fletcher. (From *The Iron Age*, Vol. 164, No. 3, July 21, 1949, pp. 78-89, 13 illustrations.

In metal cutting, most of the power is used in forcing the tool to shear and deform the metal. Both shear strength and hardness decrease at higher temperatures, and by increasing the temperature of the metal, instead of cooling it as in normal practice, it has been found possible to reduce the amount of power required for machining[1].

An investigation of the possibilities of hot machining has shown that by localised heating of the work ahead of the tool, the amount of metal removable per horse-power per minute can be considerably increased. When the material is heated to 1500° F for machining, the increase in the possible metal removal rate was found to be 300 per cent for ordinary steels, 200 per cent for heat-treated alloy steels (U.T.S. 120,000 psi), and as high as 125 to 1 for refractory metals, such as high-temperature cobalt-chromium alloys for jet turbines, etc.

Hot machining at 800° C (1472° F) had already been tried by the Krupp Company, in Germany, using cutting tool tips containing 4 per cent titanium carbide, 14-15 per cent cobalt, and the balance tungsten carbide[2]. The Krupp Co. had designed a special machine for hot planing, arranged so that the billet or plate could come straight from the furnace on to the machine.

Various attempts had been made by other investigators to heat the steel ahead of the tool by direct resistance heating, using the tool as an electrode and a contact on the workpiece above or ahead of the tool as the other electrode, but these attempts apparently had not produced practical results. Other investigations were made by Induction Machining, Inc., of Long Island City, N.Y., and by A. O. Schmidt, Kearney & Trecker Corporation, of Milwaukee[1].

The method developed by Sam Tour & Co., Inc.

and Induction Machining, Inc., is based on the use of induction heating. The investigations made were on metal bars 3 in. in diameter and 24 in. long. The percentage compositions of the metals were as follows:—

(1) *Low-carbon steel*: C 0·247, Mn 0·49, P 0·010, S 0·025, Si 0·090;

(2) *Medium "M" carbon steel*: C 0·31, Mn 0·75, P 0·045, S 0·055, Si 0·25, Ni 0·25, Cu 0·35;

(3) *Grade "AN" steel*: C 0·70, Mn 0·43, P 0·011, S 0·01, Si 0·20, Ni 1·64, Cr 0·93, Mo 1·64, V 0·02;

(4) *Grade "V" nickel steel*: C 0·41, Mn 0·81, P 0·015, S 0·028, Si 0·25, Ni 3·39, Cr 0·20, Mo 0·06;

(5) *S-816 Allegheny-Ludlum high-temperature alloy*: C 0·34, Mn 1·44, Si 0·23, Ni 19·74, Cr 19·49, W 4·33, Mo 4·17, Co 42·15, Cb 3·05, Fe 2·67.

The S-816 alloy was solution-treated at 2300° F for 3 hours, water-quenched, aged at 1400° F for 16 hours, and then air-cooled, and had a Brinell hardness of 286. The "V" grade nickel steel was heat-treated in stock lengths before cutting to 24 in. lengths to ensure uniform heat treatment and to avoid end effects. It was normalised at 1650° F for 3 hours and air-cooled, reheated at 1475° F for 3 hours and oil-quenched, drawn immediately at 1050° F for 5 hours, and air-cooled, to obtain a material with a lower draw or tempering temperature than the hot-turning temperatures, so as to be able to study the effects of hot cutting on heat treatment and hardness.

Tensile tests at elevated temperatures were made on 0·505 in. diameter "V" steel specimens which were heated for 20 minutes at the required temperature before testing. The specimens were tested in an electric furnace mounted on the tensile machine. The following average results were obtained, with pull speeds of $\frac{1}{4}$ ipm:

Nominal test temperature °F	72	500	1000	1500
Tensile strength, psi	120,000	115,500	50,300	10,200
Elongation in 2 in., per cent	21	21	30	61·5
Area reduction, per cent	61·15	53·5	84·55	88·8
Yield strength (0·2 per cent offset), psi	93,300	—	—	—

A Reed-Prentice 14 in. sliding gear-head lathe was used for the hot machining tests. It was fitted with the necessary fixtures for induction heating, gas heating, coolant lines, strain gauges, indicators and watt-hour meters. To take up longitudinal expansion of the workpiece, a spring-loaded lathe tailstock was designed.

The first coil used for induction heating was a pancake-type coil, powered from a 10 kVA generator, and mounted in a "Transite" housing designed to prevent arcing from the coil contacting the chip. Cut-outs in the Transite sides of the housing, smaller in diameter than the i.d. of the coil, prevented shorting due to test bar contact. Asbestos spacers were placed between the coil and the Transite sides, as shown in Fig. 1, and solid supports were provided to minimise coil vibration. The coil was mounted on the carriage independently of the cross slide, so that the tool could be engaged without altering the clearance between the coil and the work. The coil was set at a 3 deg. angle and near the cutting tool it was closer to the headstock, so that the cutting edge of the tool could be brought closer to the high heat zone.

The high heat zone was about $\frac{1}{4}$ to $\frac{1}{2}$ in. wide, moving along the work at about the same rate as the coil and the cutting tool. Another section of the total visible heat zone was ahead of the high heat zone and at a lower temperature. Although varying with the working conditions, the temperature of the metal at the base of the cut was sometimes barely at a visible heat, i.e., at 1100° F, when the surface being machined was at 1500° F.

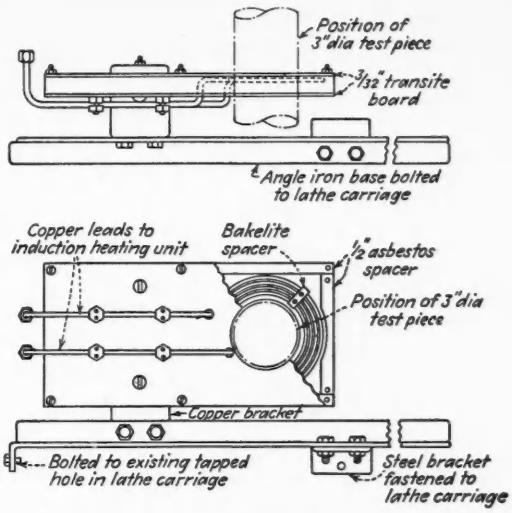

Position of 3"dia test piece
3/32" transite board
Angle iron base bolted to lathe carriage
Copper leads to induction heating unit
Bakelite spacer
½" asbestos spacer
Position of 3"dia test piece
Copper bracket
Bolted to existing tapped hole in lathe carriage
Steel bracket fastened to lathe carriage

Fig. 1. Details of induction coil.

A second coil was subsequently developed. This was a double-pancake type coil with 3½ in. internal diameter, consisting of eight turns of $\frac{5}{16}$ in. flat copper tube instead of four, and it was used with a 20-kVA water-cooled gap-type Ecco induction heating unit. This coil was capable of heating the metal surface of a 3 in. diameter workpiece to 1500° F in less than 6 seconds.

A new and improved "flux concentrator" heating unit was then built at the suggestion of the Navy. The unit consists of three coils: (1) a primary coil of 14 closely-spaced turns of $\frac{5}{16}$ in. copper tubing, insulated with glass tape and water-cooled with water pressure of 60-80 psi; (2) a single split turn secondary of copper within the primary coil, the secondary being connected to (3) a single-turn water-cooled coil of smaller diameter. The gap between the copper secondary and the work was about 1 in., and the gap between the single-turn water-cooled coil and the work was about $\frac{1}{4}$ in.

Using this coil, the grade "V" nickel steel heated to 1250° F in 25 sec and reached 1500° F shortly afterwards, with the red zone traversing to the centre of the 3 in. bar, the bottom of the 0·25 in. cut being above red heat temperature. The S-816 high-temperature alloy reached 1500° F in about 1½ min, and this temperature was held for 6½ min with a carriage travel of $\frac{3}{4}$ ipm, the temperature then dropping to 1400° F.

When gap-type high-frequency generators with multiple-turn coils were used, the coils had a considerable voltage relatively to the work. Arcing, when it occurred, was heaviest between the coil and the work; arcing between the tool and the work was lighter, although some slight pitting of the carbide tool occurred. Arcing between chip and lathe was usually light. Arcing trouble was eliminated by using a single-layer low-voltage coil and a step-down transformer connected to a 30-kVA Tocco 9000-cps motor generator, and having a properly balanced circuit with suitable condensers mounted on the rear of the lathe carriage.

Gas torches were also tested as heat sources. A curved-stem torch of the Linde Air Products Company was connected to a seven-tipped flame head and an adaptor connecting the stem to a gas mixer. A Transite shield, $\frac{1}{4}$ in. thick, was fitted to guard against flame splash in the direction of the tool. The mixer had a

rated hourly capacity of 79 cu ft of acetylene and an equal capacity of oxygen. Since a narrow heating zone was found best, the three-tip row was plugged off, and only four tips were used. The openings of the tips were No. 50 drill size, and a neutral flame was obtained, using acetylene pressure of 5 psi and oxygen at 10 psi. It was later found that a slightly oxidising flame, with about 5 per cent excess oxygen, gave less flame splash, a hotter flame, and a shorter blue cone, and was more suitable for hot machining. The torch was mounted so that the end of the flame was $\frac{3}{16}$ in. from the surface; it was later found that best results could be obtained with the flames perpendicular to the work.

Streams of coolant were directed at the work on the hot-machined surface, an inch or two behind the cutting tool to cut down the total heat, and further streams of coolant were directed on the centres at each end of the workpiece and on the tool shank. A small sheet metal shield on the tool shank just behind the cutting insert prevented the coolant from reaching the chip or the tool tip.

A specially developed tool dynamometer was used to measure tool post loads. The tests showed that for a given speed, feed and depth of cut, more heat input is required if the tool load increases. The tool load variations can thus be used with an automatic controller to vary the power input from the high-frequency source and maintain a constant temperature of the work ahead of the tool.

Tangential and longitudinal tool load measurements were also made with four SR-4 strain gauges mounted on the tool shank, the tool providing the equivalent of a support for a cantilever beam. An additional strain gauge was used for temperature compensation, and the strain gauge output was fed to an oscilloscope.

Temperature measurements were made, using contact pyrometers, optical pyrometers, thermocouples and tempilsticks. For power measurements, a watt-hour meter was connected to the power line of the lathe, and a watt-meter indicated the power consumption of the induction heating unit.

A summary of some typical test results is given in the tables below.

To heat the S-816 alloy by a gas flame, two torch heads were set up in parallel, making eight tips available for heating in one plane. One tip was closed off because it interfered with another, making seven tips operating. By reducing the carriage travel to about $\frac{3}{4}$ ipm it was possible to cut for 10 min before the surface temperature dropped from 1500° to 1200° F. With the flux concentrator coil it was possible to maintain a surface temperature of 1500-1600° F, at a carriage speed of $\frac{3}{4}$ ipm for a total of 10 min.

In machining the grade "V" nickel steel, the chip was taken off as a continuous ribbon. With the S-816 the chips broke off in short curls in lengths varying from $\frac{1}{2}$ to 2 in., and accumulated beneath the cutting tool, where they stayed at red heat for a considerable length of time.

Most of the lathe work was carried out using a carbide insert type of tool holder. For instance, for the S-816 alloy, a Super Tool Co. square insert-type right-hand turning tool was used, set at the following angles: back rake -9 deg., side rake-9 deg., end relief 9 deg., side relief 9 deg., end cutting edge 5 deg., side cutting edge 5 deg., and nose radius $\frac{1}{16}$ in. Further work is in progress regarding the tool design and tool angles most suited for the purpose. No difficulty was experienced as regards tool breakage or wear during hot-cutting, and chatter was absent.

The finish of all the hot-turned surfaces was noticeably superior to that of surfaces cold-turned under the same cutting conditions. Small transverse tears were entirely absent from the hot-cut surfaces. Microhardness surveys and metallographic examinations of some specimen cross-sections which had been subjected to hot machining at 1500° F showed no appreciable effect on the steel remaining below the cut, and this was particularly true of the "V" grade nickel steel and the S-816 alloy. The metal removal ratio, i.e., the amount of metal removed when cutting hot, as compared with the amount removed when cutting cold, was 3·9/1 for medium carbon steel, 3·3/1 for low-carbon steel, and 2·6/1 for "AN" grade low-alloy steel not heat-treated.

BIBLIOGRAPHY

[1] "Milling high-strength alloys at elevated temperatures," by A. O. Schmidt. *The Engineers' Digest*, May, 1949, p. 169.

[2] "The German hard metal industry," by G. J. TRAPP and others. BIOS final report No. 1385, item 21, p. 55.

HOT MACHINING OF CARBON STEEL

Spindle speed	73 rpm
Feed per revolution	0·015 in.
Depth of cut	0·0625 in.
Bar diameter	2·906 in.
Cutting speed	55·5 sfpm.

Temperature, °F workpiece surface	chip	Tool loading, lb tangential (torque)	longitudinal (thrust)
75–125*	450*	340–385	215–230
475	1100	285	205
600–700	1200	255	180
1000–1100	1200	195	150
1600	1750	130	135

*Estimated figures.

HOT MACHINING OF LOW-ALLOY STEEL NAVY GRADE "AN"

Spindle speed	73 rpm
Feed per revolution	0·010 in.
Depth of cut	0·065 in.
Bar diameter	2·975 in.
Cutting speed	56·9 sfpm.

Temperature, °F workpiece surface	chip	Tool loading, lb tangential (torque)	longitudinal (thrust)
75–100	750–800**	345	235
1000	1250	195	155
1575	1650	130	120

**Tempilstick reading as chip passed over cutting edge of tool.

MACHINING OF S-816 ALLOY AT VARIOUS TEMPERATURES

Heat source	Spindle speed rpm	Feed in. per revolution	Depth of cut in.	Temperature, °F work	chip	Tool loads, lb torque	thrust	Power consumption hp	Metal removed cu. in. per min.
Cold	91	0·015	0·0625	—	—	—	—	2·84	0·80
Cold	136	0·010	0·0625	—	—	410	320	—	0·80
Gas	73	0·010	0·110	1200	—	350	250	—	0·76
Gas	73	0·010	0·110	1300	—	230	230	2·01	0·76
Gas	73	0·010	0·110	1500	1800	110	190	1·93	0·76
Gas	73	0·015	0·140	1500	1800	—	—	—	1·44
Flux coil	171	0·010	0·187	1500	—	—	—	4·08	3·01
Flux coil	171	0·015	0·187	1500	—	—	—	5·23	4·52

Linking up the Waters of the Ob with the Aral and Caspian Seas

By M. M. DAVIDOV. (From *Gidrotekhnicheskoe Stroitelstvo*, No. 3, 1949, pp. 6-11, 3 illustrations.)

QUITE a number of economically important regions of the Soviet Union, among which the Urals, the Volga region, Western Siberia, Central Asia and Kasakhstan are pre-eminent, depend for their development on water resources, as the main economic problems are the fertilisation and afforestation of the wide steppes.

The Volga and its tributaries are in an advanced state of exploitation (mainly for power and navigation), though development is proceeding where irrigation systems and further hydro-electric schemes are concerned. An unavoidable consequence of this will be the reduction in the water volume of the Volga reaching the Caspian and a corresponding fall in level of the latter. The reduction was estimated to be of the order of 121 million acres-ft. ($14{\cdot}8 \times 10^{10}$ tons) water annually, half of which is required for objectives of primordial importance. This would totally upset the present hydrological conditions of the Caspian, which must be preserved in the interests of climatic stability and of hydrological balance of the catchment areas of the rivers of Central Asia, Kasakhstan and Western Siberia. Thus, the water loss must be made up.

Central Asia and Kasakhstan have enormous water requirements, the vast expanse of arable ground offering practically inexhaustible potentialities for the high-grade cultivation of commercial products and food-stuffs (cotton, rubber, rice, etc.). In addition, these regions abound in valuable raw materials, yet are poor in water supplies, which even at present are nearing exhaustion.

The greatest streams of Central Asia, Amu-Daria and Syr-Daria belong to the basin of the Aral Sea. The planned system of irrigation canals from the Amu-Daria will nearly drain this giant river, and the same fate threatens the Syr-Daria when its hydro-power system is completed. The waters of the Aral Sea catchment area will eventually irrigate 20 million acres, corresponding to the removal of 40 million acres-ft of water from the Aral Sea, the surface area of which would shrink from 27,000 to 4,750 sq miles. This water will have to be restored by tapping the water resources of other basins having an unused water surplus. The Turanian lowlands, with an area of 62 million acres, need 182-202 million acres-ft water annually, the whole Aral-Caspian region requiring about 243 million acres-ft or 350,000 cu ft per sec.

Yet the Ob and Yenisei rivers in neighbouring Siberia carry 730 million acres-ft per annum, practically unused, to the Kara Sea. The idea of transferring these unused water reserves of Western Siberia to the Aral-Caspian would thus appear to suggest itself, due regard being taken to the utilization of the kinetic energy of the rivers for power production.

The project for the solution of this problem envisages the erection of a dam of 256 ft height on the Ob, below the influx of the Irtish, so that a storage lake of a capacity of 3650 million acres-ft and a surface area of 96,000 sq miles would be formed. This would spread the water level, raised to the 246 ft mark, throughout the levels of the Ob and its tributaries, Irtish and Tobol, down to the watershed between Western Siberia and the Aral-Caspian lowlands, the so-called Turgai Gates, rising to about 85 ft above the level of the projected storage lake.

The watershed is pierced by a canal of an average depth of 131 ft, a maximum depth of 246 ft, and a length of 580 miles. It would further follow the bed of the Turgai river, pass lake Chelkar-Tangis and fall into the Aral Sea. Proceeding along the natural depressions on emerging from the Aral Sea, the Siberian water will reach the Sari-Kamish basin, filling it up, and hence, along the dry bed of the Usboi, will join the Caspian. The waterway will have a total length of 2,500 miles, 1,120 miles of which is constituted by lakes, seas and storage basins, 590 miles by the dry beds of former rivers, and 790 miles by artificial canals. The total difference in level of the projected waterway from the Southern slope of the watershed to the Caspian is 295 ft, which will be used for energy production in 4 huge hydro-electric power stations.

The enormous amount of work and capital investment involved entail a subdivision into stages which subdivision is not only confined to the overall program, but even applies to its individual parts, such as the power station on the Ob, near Belogorie, to be erected in 2 or 3 stages, with a gradual rise of the head exploited and, thus, of the installed power and output. Likewise, the canal across the Turgai Gates in its first stage will not be able to carry the entire available volume of the Siberian waters. The whole system of power stations will eventually produce 81,000 million kWh per annum.

After the completion of the first stage of the work, it will be possible to take 25 million acres-ft of water from the Ob storage lake, sufficient to irrigate 10 million acres of steppe along the shores of the Caspian. During this period it is estimated that the resources of the Amu-Daria and Syr-Daria will have become completely exhausted, and the removal of a greater volume of water from the Ob will already have resulted in the reduction of the output of the Belogorie power station.

To restore this power loss during the subsequent phases of execution of the project, when a steadily rising volume of water will be required from the Ob reservoir, the plan provides for a transfer of Yenisei water to the Ob by the erection of hydraulic works on the Yenisei, in the region of the Stony Tunguska, whereby its waters are directed into the storage reservoir on the Ob, using the system of tributaries of Yenisei and Ob, i.e., Kas and Ket. The water volume of the Yenisei within the reaches of the transfer system is estimated at 370,000 cu ft per sec, of which 35,000 cu ft per sec must be kept in the Yenisei to maintain its navigable depth; yet the latter volume itself may yield an energy output of 750,000 kW in hydro-electric power stations. More substantial power will be gained (2·6 million kW) in a station on the river Ket, within the hydraulic linkage system Ob-Yenisei, having a head of 115 ft and working on the great transferred water volume.

The project will provide a new deep waterway, navigable for sea-going ships, between the mouths of Yenisei and Ob and the Caspian. The transfer of water to the Southern slopes of the Turgai Gates permits the irrigation of 62 million acres in Central Asia and Kasakhstan and the afforestation and fertilisation of waste lands of an area of about 50 million acres.

Closely connected with irrigation and fertilisation are the changes in climate, the importance of which is inestimable. The dry winds, so disastrous for the cultivations in the Don and Volga lands, originate from the deserts of the Aral-Caspian plain. The provision of forest belts in the South of the European part of the USSR should prove to be the decisive factor in the fight against devastating droughts, and the irrigation, fertilisation and afforestation of the Turanian steppes will, beyond any doubt, lead to final victory in this campaign by eliminating the conditions which produce these droughts. In addition, the increased evaporation due to the introduction into the Aral-Caspian plain of supplementary quantities of water on such a generous scale will have a considerable influence on the water volume of the rivers in Central Asia, Kasakhstan and the Urals, thus providing a further source for irrigation and improvement in the means for feeding the existing and planned irrigation systems as well as power stations.

DESIGN TRENDS AN[TH]

OF MACHINE TOOL

MILLING AND GRINDING MACHINES PART V

With Fig. 128 we have been anticipating the subject of the next chapter, that of internal grinders. However, this is a dual-purpose grinder, and many external grinders, while designed primarily for external work, can be fitted with internal grinding attachments. Fig. 129 shows a Churchill universal grinder, model PBW (12 in. by 36 in.), in which a change-over from external to internal grinding can be effected without removing the grinding wheel.

Hydraulic forward and return wheelhead traverse with diminishing feed on the forward movement is fitted to the Churchill plain grinding machine BW (10 in. by 36 in.) shown in Fig. 130. The automatic sizing cycle using an electrically controlled "Automike" spring gauge consists of :—

Quick approach of wheel to grinding position;
Work starts rotating;
Diminishing feed during grinding;
Adjustable dwell at "size";
Signal light during "sizing dwell";
Quick withdrawal of wheel to rest position;
Work stops for removal.

This equipment makes Churchill plain grinding machines fully automatic in operation, as it is only necessary for the operator to insert the work, start the machine, and remove the work when the head runs back. The operator has only to move one lever for the machine to begin and complete its cycle. The diagram, Fig. 131 explains the automatic cycle. The dotted line shows the metal removal with the usual constant plunge feed rate of the ordinary grinding machine. Note the absence of the "finishing" and "sizing" effect as given by the Churchill diminishing feed shown by the full line. To obtain the same result without diminishing feed, a longer period of dwell at the sizing point would be necessary, thereby reducing output. For automatic sizing to extremely fine tolerances the Churchill Machine Tool Co. have now introduced the Fulcro-Sizer," Fig. 132, in which the wheelhead slide is set at a definite position and left in that position throughout the operation. Feed is applied by tilting the table carrying the work, the table being mounted at its inner side on knife edges. The front of the table is lifted by a link motion operated by a tension rod moved hydraulically from a control box at the right-hand end of the table. Movement of this tension rod is controlled electrically and the grinding cycle is as follows :—

The operator drops the work into

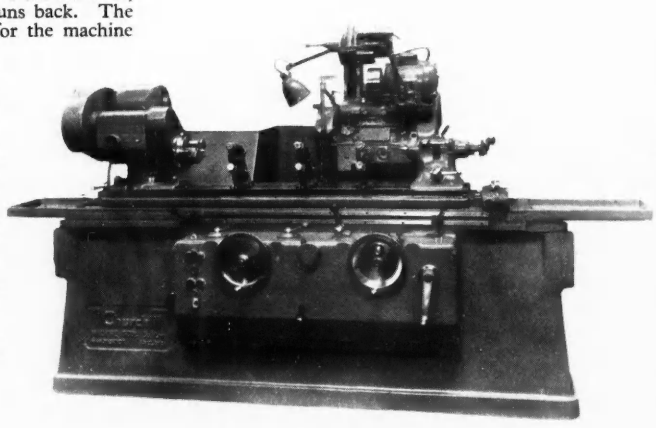


Fig. 129 (above). **Churchill Model "PBW" 12 in. by 36 in. universal grinding machine. The internal grinding spindle can be seen in position in the bracket, which is swung out of the way when the machine is being used for plain grinding.**

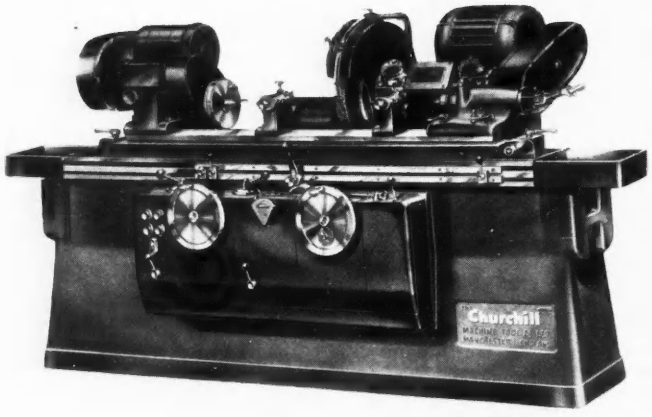


Fig. 130 (left). **Churchill Model BW 10 in. by 36 in. plain grinding machine.**

THE STYLE

TIBOR HAAS, A.M.I.MECH.E., A.F.R.AE.S.

a suitable cradle and starts the automatic cycle by moving the control lever. The tailstock moves in under hydraulic control, the work being thus picked up between centres. The table then rocks quickly towards the wheel by an amount depending on the amount of metal to be removed. At a preset point, the slow feed for the actual grinding operation begins, and continues until the peak or sizing position. The design of the link motion ensures that the rate of feed is steadily reduced until it becomes zero at the sizing point. From then onwards the table remains at the " dwell " position, the time of the dwell being pre-set on the Churchill electronic " dwell " control. This period during the cycle is shown to the operator by an indicating light in a panel on the wheelhead. At the end of the dwell period, the table automatically drops back to its original position, and work rotation stops. The tailstock then automatically retracts, dropping the workpiece back into the cradle. With this machine it is possible to grind a long series of components to within a tolerance of $\pm$ 0·00005 in.

Fig. 133 shows another Churchill plain grinder, model BW (10 in. by 60 in.). All these machines incorporate the new Churchill standard control apron, which is of very neat appearance and in which all mechanical, electrical, and hydraulic controls are centralized for convenient operation and easy servicing. Certainly, the convenient grouping of the controls does much to improve output figures. Many Churchill features which have proved their worth over years are retained in these machines. They include the patent " Hydrauto " wheel spindle bearing adjustment, in which the oil film between spindle and bearings is kept at a minimum thickness under all working conditions.

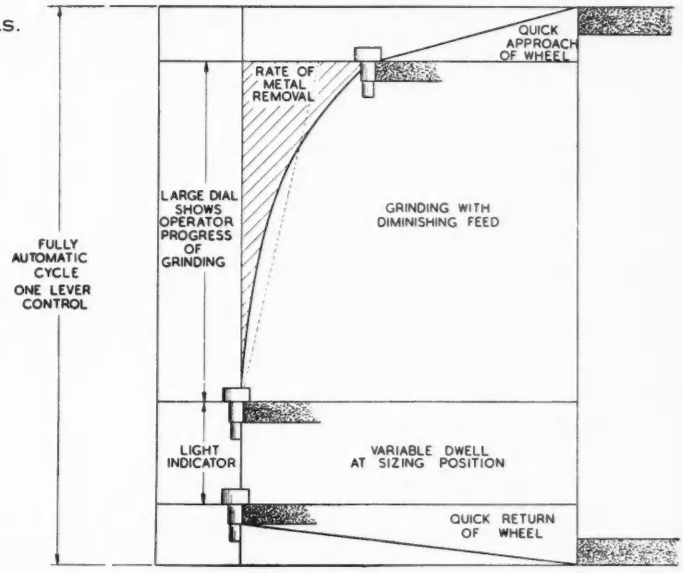

QUICK APPROACH OF WHEEL
RATE OF METAL REMOVAL
LARGE DIAL SHOWS OPERATOR PROGRESS OF GRINDING
GRINDING WITH DIMINISHING FEED
FULLY AUTOMATIC CYCLE ONE LEVER CONTROL
LIGHT INDICATOR
VARIABLE DWELL AT SIZING POSITION
QUICK RETURN OF WHEEL

Fig. 131. **Illustration of the automatic sizing cycle as applied to the Churchill plain grinding machine shown in Fig. 130.**

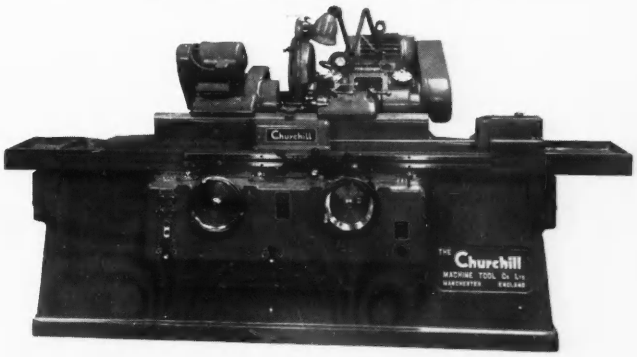


Fig. 132 (above). **Churchill 10 in. by 36 in. "Fulcro Sizer BW" plain grinding machine.**

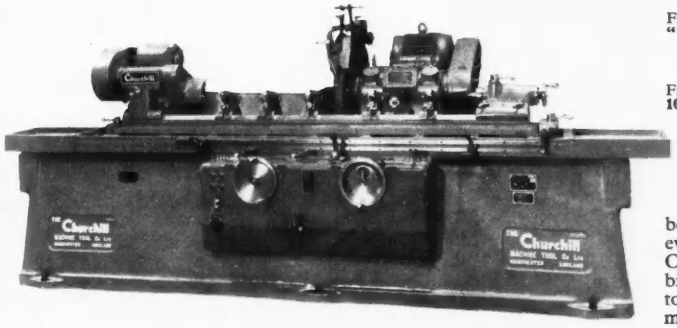


Fig. 133 (left). **Churchill Model "BW" 10 in. by 60 in. plain grinding machine.**

Fig. 134 shows what is believed to be the largest plain grinding machine ever made. It was designed by the Churchill Company for grinding turbine rotor shafts weighing up to 14½ tons for power station generating equipment.

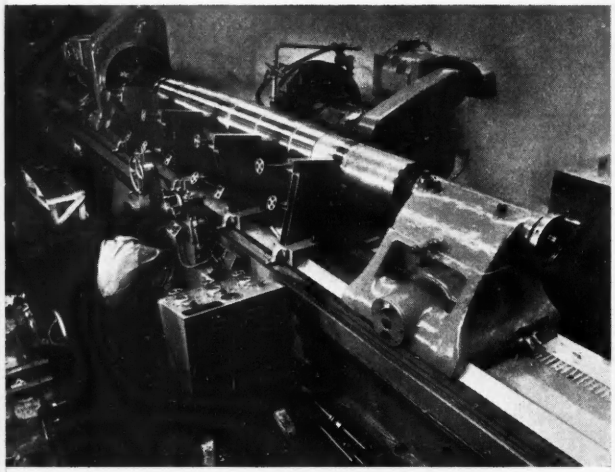


Fig. 134. **Churchill 40-ton plain grinding machine for turbine shafts.**

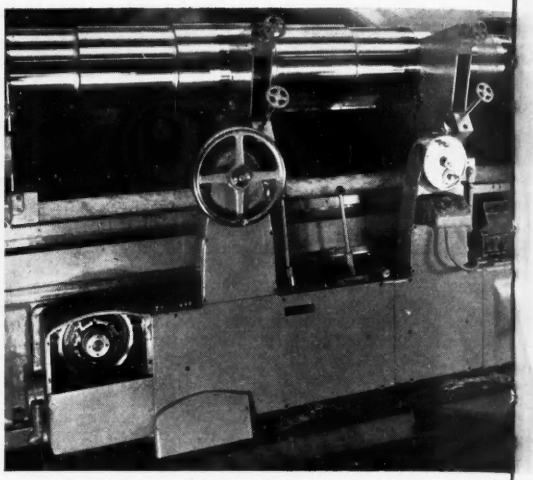


Fig. 135. **Controls of machine shown in** Fig. 134.

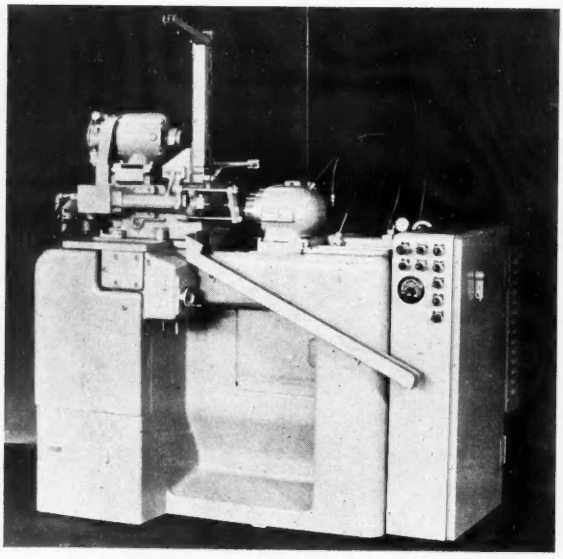
The machine has a maximum swing of 54 in., will admit a length of 288 in. between centres, weighs approximately 40 tons, and has a length of 57 feet. An outstanding feature of this large machine is the very neat layout of the control apron, illustrated in Fig. 135. Owing to the large diameter of the shafts to be ground, the machine is of great height as compared with the average plain grinding machine, and the operator stands on a platform affording him an eye-level view of the mirror on the wheelhead, in which he can see the grinding wheel making contact with the work. The two controls which will be in use most frequently—the wheelhead feed and the hand traverse to the table—are raised to a comfortable operating level, and the electrical control desk is mounted on the right-hand side of the platform (Fig. 134). The apron contains the grinding wheel feed gearing, the traverse drive gear-box and reverse mechanism, the hand traverse reduction gear, also the variable dwell mechanism which operates at each reversal of the table traverse, and the power traverse disengagement lever.

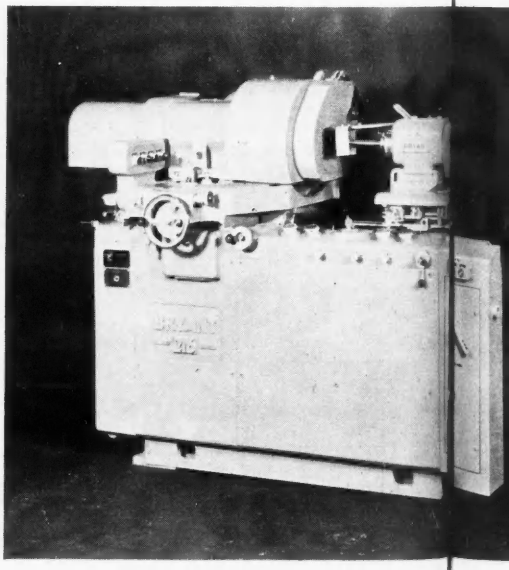
CHUCKING-TYPE INTERNAL GRINDING MACHINES

In the foregoing, external cylindrical machines fitted with internal grinding attachment were described. The machines dealt with in this Section are specifically designed for internal work and termed chucking grinders. Not only chucks, but also face plates, collets or fixtures can be used for holding the work. These grinders are available for production finishing of bearings and of bores in gears and precision machine parts, but face grinding can also be carried out where squareness is desirable.

Generally, these grinders are equipped with a

Fig. 136 (below). **No. 1209 Bryant automatic internal grinder.** Chuck swing 9 in., max. traverse stroke 6 in., max. grinding length 3 in.





reciprocating wheelhead and a rotary workhead which is mounted on a movable cross-slide with means for angular adjustment.

The American Bryant Chucking Grinder Company has specialised in building chucking-type internal grinders since 1909 and has always adopted a progressive outlook in engineering, including questions of design. This is borne out by their latest machines, some of which are shown in Figs. 136 to 139. The No. 1209 machine (Fig. 136) is designed for high production grinding of small and medium-size bores, as in ball bearing races and bushings. The grinding cycle proceeds automatically and the operator's attention is required only for loading and unloading the work and tripping the valve to start the cycle. As can be seen from the illustration, this grinder is equipped with an automatic loading and unloading device. Bearing cups are fed down the vertical slide from a hopper, when a pick-off arm puts the cup into the workhead chuck while one diamond trues the wheel. The wheelhead advances to rough-grind, retracts for wheel truing, and then advances for finish grinding. As it withdraws, the piece is ejected by air to strike the shield on the pick-off arm and drop into the inclined ejector chute. High production rates are obtained because of a special feature. The loader centres the part from the rough bore. When this is permissible, grinding of the outer diameter, as normally has to be done for chucking, is eliminated.

Another special feature, which is also incorporated in other Bryant machines, consists in supporting both the workhead and wheelhead on cylindrical slide bars by preloaded bearings. These slides are sealed against grit by neoprene bellows, and do not require regular lubrication. There is no compound slide under the grinding wheel, as size is controlled by the cross-movement of the workhead. The wheel is directly driven by a high-frequency electric motor which replaces the belt-driven wheelhead. This drive has been developed to run small grinding wheels at their most efficient cutting speed, which is about 5000 surface feet per minute. The high-frequency wheelhead permits wheel speeds up to 100,000 rpm. A unit consisting of a frequency converter or high frequency generator driven by a standard motor is used as a source of high frequency alternating current required for the wheelhead motor.

Using this method, the Bryant Company achieved speeds up to 200,000 rpm for very small holes.

Ten years ago, hydraulics marked the trend of the up-to-date machine tool. Five years ago, electronics

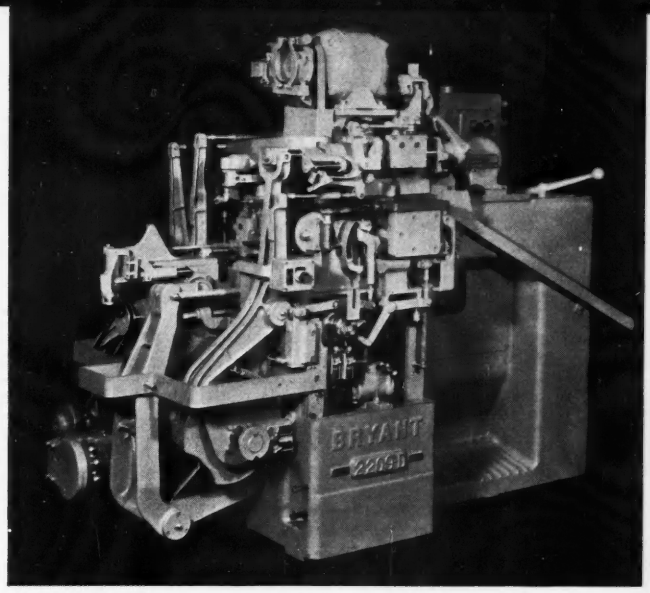


Fig. 137. **No. 2209 Bryant cam-controlled automatic internal grinder.** Casing removed.

came into prominence. Each of these trends multiplied production and not only increased both accuracy and safety, but also cut operator fatigue. However, each introduced new maintenance problems, and demanded specialists and a greater number of skilled men for maintenance supervision. Some machine tool users, particularly the automotive industry, have objected to these new machines[26].

It is, therefore, interesting to see in the new No. 2209 Bryant, Figs. 137 and 138, an internal automatic grinder stripped of all hydraulic and electronic devices. All elements are cam-operated (and readily recycled) and the only electrical devices are limit switches,

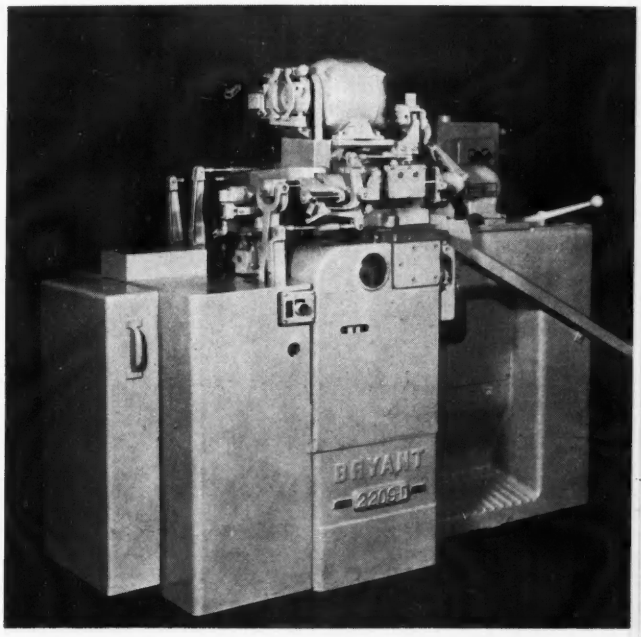


Fig. 138 (right). **No. 2209 Bryant cam-controlled automatic internal grinder.** Casing in position.

Fig. 139 (left). **No. 1216 Bryant automatic internal grinder.** Chuck swing 16 in., maximum traverse stroke 15 in., max. grinding length 6 in.

solenoid brakes and three motors, for the high-frequency wheelhead, workhead and main drive (which operates main cam and coolant pump). Low-speed cam operation avoids cam clank, so that the machine is relatively quiet. There are ten cams controlling all steps in the cycle. Feed and wheel dressing are automatic, so that one operator can handle four machines. The diamond dressers operate between rough and finish grinds, and thus control hole size. Wheel wear is compensated for automatically, and when a wheel wears out (about once per hour), an automatic telltale shuts the machine down and lights a red signal. Facing and bore grinding can both be done because the wheelhead is set at a slight angle to avoid heel drag on the wheel. Dressers compensate for this setting.

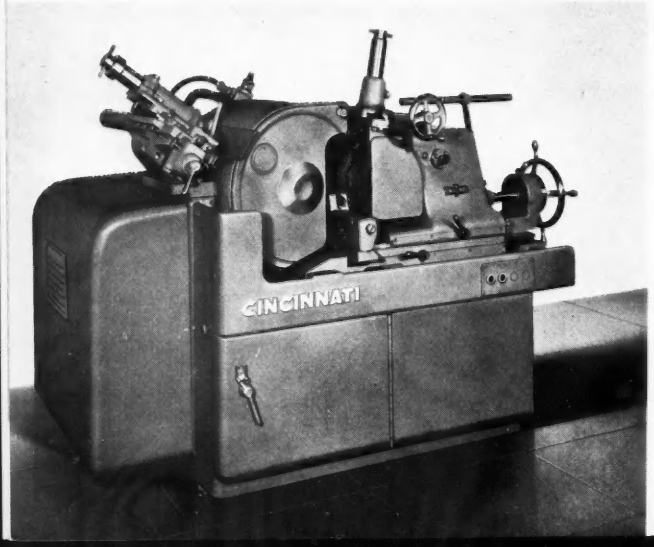
This single-purpose machine is, in function, the same as the No. 1209, but all electric controls are replaced by cams. The cycle is fixed and cannot be changed; the entire set-up must be designed around the workpiece.

The No. 1216 Bryant internal grinder, Fig. 139* is a heavy automatic machine, the same operator being able to operate two or more of these. The cross-feed and traverse movements of the machine are hydraulically operated. Cycle control is accomplished electrically so that the cycle can be readily changed to suit varying working requirements. Automatic sizing is also provided.

The Swiss Voumard internal grinder shown in Fig. 140 is available in a number of types, either semi or fully automatic. The outstanding constructional feature of this machine consists in the mounting of the workhead on an independent slide at the rear of the grinding wheel slide. The workhead can be clamped on the rear slide in any position, and the slide swivels at any angle up to 90 degs. in relation to the wheel slide. This feature allows face and taper grinding on the end of workpieces up to 21 in. long supported by chuck and steady. The machine shown in Fig. 140 is equipped with a face grinding attachment with cup wheel and can be seen in its swung-back position. The hydraulically operated truing attachment mounted on a separate slide can also be seen in the illustration.

The Kummer internal grinder, Fig. 141, is noteworthy for its clean lines and simplicity, but also for the fact that a very large number of its parts is identical with the cylindrical grinder shown in Fig. 118 made by the same firm.

*This illustration shows " No. 216 " as the picture was taken before the machine number was changed to 1216.



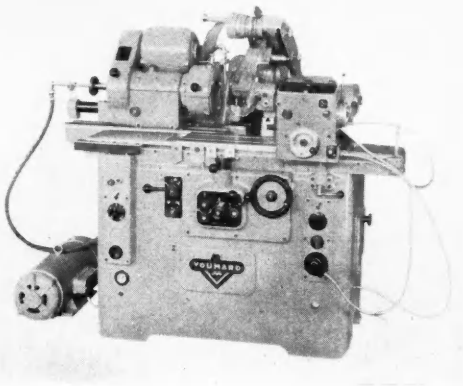


Fig. 140. **No. 4 Voumard internal grinding machine.** Max. diameter of work 6 in., max. grinding length 6 in.

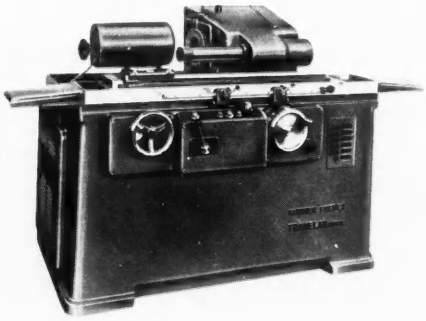


Fig. 141. **Kummer Ri 122 internal grinding machine.** Max. diameter of work 9½ in., max. grinding length 11·8 in.

CENTRELESS-TYPE GRINDING MACHINES

The centreless principle has wide application in both external and internal grinding machines.

(a) *Centreless Cylindrical Grinding.*

While the centreless grinder is identical in purpose to that of the centre-type grinder, the two machines differ as much in their performance as they do in their principle of operation and appearance. This will be illustrated by taking the No. 2 centreless Cincinnati grinder (Fig. 142) as an example.

The basic machine elements of a centreless grinder comprise a grinding wheel, a regulating wheel and the work-rest blade. The grinding wheel serves as the tool, and the regulating wheel, by applying pressure against the workpiece, controls sizing and feeding movement of the workpiece, while the work-rest blade both supports the workpiece and guides it between the wheels. There are three main classes of centreless grinding.

Fig. 142. **No. 2 Cincinnati centreless cylindrical grinder.** Max. diameter for short work 4¾ in., for bar work 2 in. dia. × 18 ft long.

1. *Through-Feed*

This means axial movement of the workpiece relative to the grinding wheel, accomplished by the fact that the regulating wheel is set at an angle relative to the grinding wheel.

2. *Infeed*

This method is similar to the centre-type plunge or form grinding, generally employed in the grinding of work pieces where some part is larger than the diameter to be ground. There is no relative axial movement of the work, and the width of the grinding wheel is so chosen as to cover the length to be ground.

3. *End Feed*

This method is applied to taper work. Either the grinding wheel or the regulating wheel or both must conform to the required taper. All the machine elements are in fixed relation to each other. Work is fed in from the front, either manually or automatically, to a fixed end stop.

This flexibility of design makes it possible to fix all elements in one spot, to immobolise the work-blade relative to the grinding wheel, or to fix its position relative to the regulating wheel.

The advantages of centreless grinding are manifold. As the workpiece has a three-line contact with the wheels and work-rest blade, a greatly increased grinding force can be applied without distortion of the most slender parts. This results in great speed of metal removal. Operating time is reduced because of the absence of centering and other adjustments and because of the ease of loading and unloading. Because out-of-roundness is corrected across the diameter and not on the radius as with the centre-type, less grinding stock is required, and grinding wheels are better utilized. Ease of handling, both manually and automatically, is an additional advantage as it permits the use of a number of feeding arrangements.

Some further remarks on the Cincinnati shown in Fig. 142 : the large sheet metal guard at the left-hand end of the machine covers the motor and Vee-belt

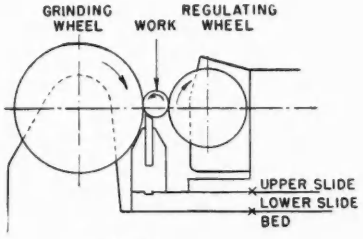
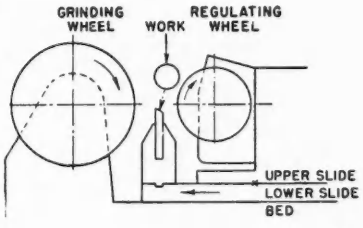


Fig. 143

Figs. 143-145. **Methods of feed.**

For through-feed and end feed work, both slides are locked ; grinding wheel, regulating wheel, and work rest remain in fixed position relative to each other. Work is fed between these elements, along the line of its own axis.



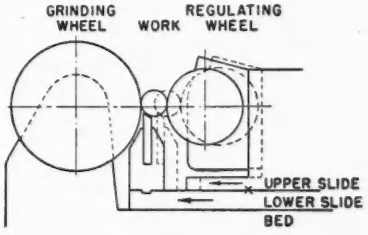
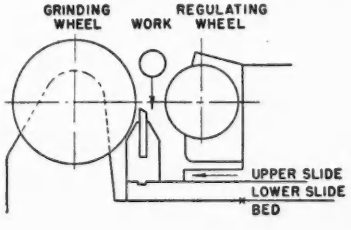


Fig. 144

For infeed work, the movement of the regulating wheel towards the grinding wheel establishes grinding contact. This is usually done by locking the upper and lower slides together, thus advancing the work-rest with the regulating wheel (Fig. 144) but with upper slide construction it can also be done by locking the lower slide to the bed, and advancing the regulating wheel to the work-rest (Fig. 145).



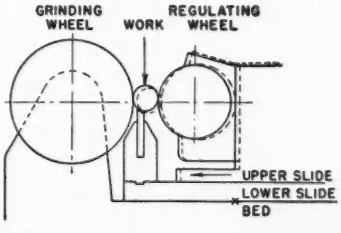


Fig. 145

On the Cincinnati (Figs. 143 to 145), the grinding wheel is on a fixed mounting integral with the bed. The work-rest is mounted on a slide (lower), and the regulating wheel unit on another slide (upper) which is itself mounted on the lower slide. The upper slide, carrying the regulating wheel unit, can be locked to the lower slide, and the lower can be locked to the bed.

drive, improving the appearance as compared to the previous design, which merely guarded the belts. The pilot wheel at the right-hand end of the bed presents a much better appearance, and incorporates a larger micrometer dial for accurate adjustments. The clean appearance of this machine is enhanced by the fact that all electrical elements are built-in. Note the hinged cover directly below the name " Cincinnati." Behind

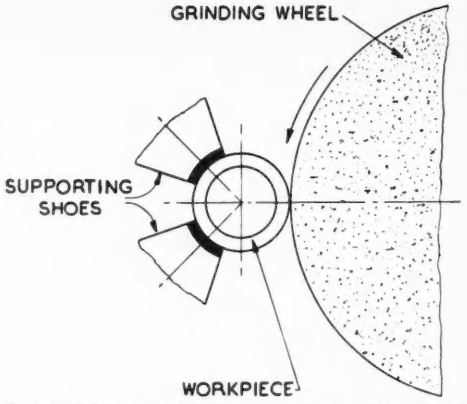


Fig. 146. **" Micro-Centric " principle of centreless cylindrical grinding.**

this cover will be found the entire assembly of electrical controls. The external handle of this cover is interlocked with a safety disconnecting switch. Push-buttons, too, are built in and are positioned within easy reach of the operator. This exemplifies a trend which has come to stay; the control boxes have been taken off the supporting posts and walls of the shop, and they are not indiscriminately attached to the machine as the electrician's afterthought, but are placed where they belong.

There is another centreless type Cincinnati cylindrical grinder, known as the Micro-Centric. Fig. 146 explains this principle, which produces a high degree of accuracy in sizing, roundness and squareness. It lends itself to the finishing of precision parts of the concentric ring type, such as anti-friction bearings.

The work is not clamped or chucked; instead, it is rotated through skiving action induced by a drive plate. Rotation of the drive plate holds the work firmly down on two supporting shoes (Fig. 146) rounding it off by making the workpiece revolve within its own periphery, exactly square with the driven face.

Centreless grinding is being increasingly used in the production of small and slender parts manufactured from wire, especially certain types of barbed needle used in the felt industry. These are produced in pairs from 0·80 per cent carbon steel wire, a typical needle being shown by Fig. 148. It will be appreciated that the centreless grinding of such a piece on the parallel diameters, tapers and points presents a number of difficulties, especially in connection with the points, and the British Scrivener No. 2 controlled-cycle centreless grinder No. 147 and special equipment used for this work have a number of interesting features. Fig. 148, in which the diameters and tapers of the piece are greatly exaggerated, will show how the problem of a point (due to possible interference of the two wheels) is overcome. Each wheel is trued to the required profile by means of a hydraulically operated form-truing attachment controlled from a suitable former, by means of which it is an easy matter to re-true either wheel when necessary.

Full-automatic operation is possible mainly due to the employment of the controlled-cycle method of automatically advancing and withdrawing the regulating wheel and piece for each grinding cycle. The selection and loading of the piece to the machine by means of a special magazine is interesting, and is best considered in two stages, as can be seen from the diagrams in Fig. 149. The blanks are loaded into the magazine *A*, and

(*Continued on page* 138)

Fig. 147. **Scrivener No. 2 controlled cycle centreless grinder.**

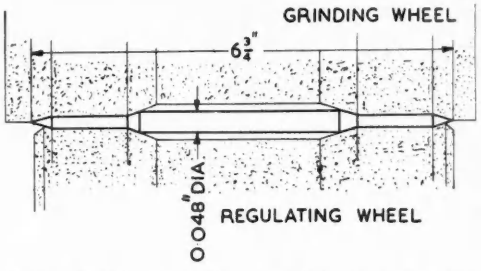


Fig. 148. **Work done on the Scrivener grinder shown in** Fig. 147.

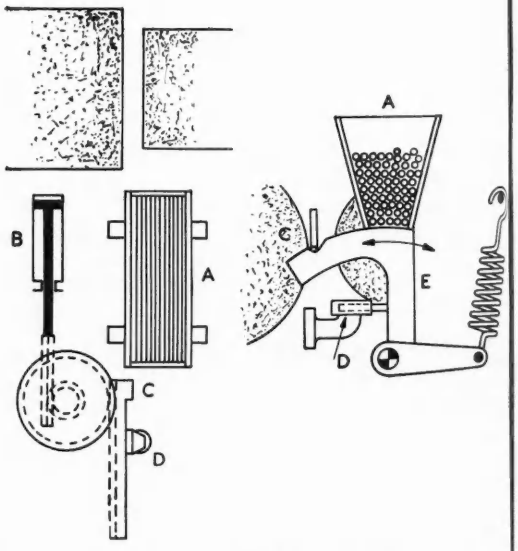


Fig. 149. **Principle of magazine and feed gear attached to the Scrivener grinder,** Fig. 147.

CLASSIFIED ABSTRACTS

Numerous important abstracts which, for lack of space, cannot be published in our main editorial columns, are regularly included in condensed form in this section. Subscribers may obtain photostat copies of all original articles at cost.

HEAT, PRESSURE, AND COMBUSTION INSTRUMENTS

Novel Steam Purity Meter

By A. A. MOSTOFIN. (From *Elektricheskie Stantsi, Russia*, Vol. 20, No. 12, December, 1949, pp. 19-21, 2 illustrations.)

IN apparatus for measuring steam purity by the electrical conductivity method, it is essential to make provision for the removal of ammonia and carbon dioxide by degassing the condensate obtained from the steam sample. A new type of degassing chamber for use with steam purity measuring apparatus was developed at the Central Boiler and Turbine Institute in 1947. In this apparatus, condensation of steam sampled from the steam main is effected by air cooling under full steam pressure in a non-insulated vertical cylindrical chamber, whence the condensate is passed through a throttle valve into an expansion chamber in which atmospheric pressure prevails.

Condensate is withdrawn from the expansion chamber at atmospheric pressure and 212° F and passed between concentric electrodes of stainless steel for measurement of its electrical conductivity. The flash steam generated in the expansion process is collected in a separator and used as heating steam in the steam jacket surrounding the electrode housing, so as to keep the latter at constant temperature. The electrical part of the instrument comprises a bridge circuit with galvanometer, or a direct reading instrument.

On installing this instrument in a large steam plant, in which the feedwater contained 2-3 parts per million ammonia, it was found that a steam contamination of 2-3 p.p.m. was indicated in place of a reading of 8-10 p.p.m. recorded by an instrument not incorporating the new degassing device. The final ammonia content of the sample was found to be reduced to 0·1-0·2 p.p.m. Complete removal of the ammonia content would have resulted in an indication of 1 p.p.m. The new degasser is claimed to remove from 75 to 90 per cent of the gases contained in a steam sample.

IRON AND STEEL

Industrial Extrusion of Steel Under the Hydraulic Press

By H. STEINBACH. (From *Revue Générale de Mécanique, France*, Vol. 34, No. 13, January, 1950, pp. 34-36, 5 illustrations.)

THE extrusion process itself is well known and so are the difficulties of its application to the industrial manufacture of steel sections, i.e., high temperatures, scale formation which ruins the dies, heat losses, and lubrication problems. Two French engineers studying the problems of lubrication at high temperatures and pressures, however, found a promising solution, and tests took place in France during the war. Immediately after the liberation, work was started on a factory building and, in order to save time, engineers began assembling the hydraulic press on site while building operations were still proceeding.

This 1500-ton press is fed by two high-pressure pumps, each of 215 hp, and a compressed-air accumulator of 330 gallons capacity. The frame and die control are so arranged that working is not adversely affected by the heat expansion due to the introduction of the hot ingot into the extrusion receiver. The ingot is automatically transported from the furnace to the receiver and fed into it by an automatic device actuated by low-pressure oil. In order to reduce the extrusion time and, therefore, the heat losses, the press must operate suddenly and with great force. The hydraulic distribution lines thus have large diameters and the valves are centrally controlled by means of hydraulic jacks; some of them are under manual-lever control, so that the valves can be opened progressively without shock, and the pressure timed at will.

The new factory has gradually extended its manufacturing programme to include the extrusion of many types of tubes and sections, using a wide variety of alloys. Die wear is not excessive and compares with that of the normal extrusion of copper alloys. Sections are usually extruded first and then finished by cold drawing. Rather thick and simple sections are the most economical, but even complicated sections can be produced, provided their wall thickness is greater than $\frac{3}{16}$ in. Special tee and channel sections can be made of plain carbon steels, alloy steels, and even stainless steels. Hollow and undercut sections can easily be extruded and subsequently cold-drawn to gauge. Alloy-steel tubes for ball bearings and stainless steel tubes for the chemical industry have been successfully manufactured. No other process can produce rough sections with thinner walls in one pass. Extrusion does not affect the steel qualities in any special manner. Normal heat treatments are used wherever the amount of strain-hardening might affect the required properties of the steel.

Determination of the Power Required for Cold-Drawing of Steel Bars

By F. BOEHM. (From *Stahl und Eisen, Germany*, Vol. 69, No. 25, December 8, 1949, pp. 931-938, 11 illustrations.)

THOUGH the *force* needed to cold-draw steels has been studied intensively and can be calculated to a fairly high degree of accuracy from the formulae developed by different authors, there exist, as yet, but few data for determination of the *power* requirements. The author of this article, therefore, attempts to correlate, in a systematic form, and for direct use in practice, the results of about 1500 measurements taken during the industrial drawing of steel in different workshops on benches of different designs. The measurements were taken on round bars from $\frac{1}{2}$ to $3\frac{1}{8}$ in. drawn diameter, with reductions of 0·1 and 0·18 in. on the diameter, and at drawing speeds ranging from 3·3 to 82 fpm. Steels used were plain carbon steels (as rolled) from 0·1 to 0·45 C, and heat-treated alloyed steels (1·2 C, 0·7 Cr, 0·1 V, and 1·2 C, 0·2 Cr, 1·0 W), stainless steel (0·2 C, 14·0 Cr), and 18-8 steel. The measured electric consumption of the motor represents the total power required, including the motor losses, and is mainly dependent on the following six variables: cross-section, resistance to deformation, area reduction, speed of drawing, entrant angle of die, and coefficient of friction. The differences in workshop procedure and bench design hardly influence the results.

POWER FOR EVERY PURPOSE—BY FORD

The fact that Ford Engines are used for so many different kinds of industrial equipment proves not only their versatility but their well-earned popularity. Manufacturers have specified these tough, precision-built engines for widely different kinds of machinery — cement mixers, pumping sets, road rollers, stone crushers, air compressors and many other major items of industrial equipment. Users have found them tough, steady workers, utterly reliable and extremely simple to maintain. They range from 23 to 85 b.h.p. and there is also a Petrol/Vaporising Oil Engine for particularly heavy work. Genuine, low-priced Ford Spares are available throughout the country.

The advice of our Industrial Unit Department is freely at your disposal on any power problem.

Ford ENGINES

8 H.P. 10 H.P. 30 H.P.

FORD MOTOR COMPANY LTD., DAGENHAM, ESSEX

FOR INDUSTRIAL EQUIPMENT

The friction coefficient is, in general practice, fairly constant. There also exists an optimum die angle for which the drawing force is a minimum. From known formulae, the ratio of the minimum force required to that required for a given, used, die angle can be calculated, and it is assumed that the power varies in the same ratio. Thus, all the power requirements can be reduced to those for the optimum die angle, and this has been done throughout the evaluation of the test results. The resistance to deformation is taken to be the mean yield strength of a steel before and after cold-drawing, and is known from tensile tests. If now the concept of a "specific power" is introduced, i.e., the power required to draw unit cross-section (of the drawn bar) of a steel of unit resistance to deformation, it is found that for any given speed, the specific power, as a function of the percentage area reduction, is represented by a fairly simple curve irrespective of material and size. Thus, for this one speed, the values of the curve, multiplied by the actual value of the resistance to deformation of the steel and by the cross-sectional area of the drawn bar, readily give the power requirements for a chosen area reduction. A different curve would have to be drawn for each speed.

By this method of representation, the motor power is given as a function of four variables only, i.e., cross-section, area reduction, resistance to deformation, and drawing speed. The test results can now be re-arranged in various ways so as to supply information in the most useful manner for practical purposes. For instance, for a certain type of steel and a given absolute reduction in diameter, the motor power may be represented as a function of the drawing speed, with oblique lines of constant drawn diameter as parameter lines. From such a graph, the greatest drawing speed for a given bar size, or the largest bar to be drawn at a given speed, can immediately be determined for a given motor power if the losses due to intermittent working on partial load are considered separately. If different steels are compared, use may be made of the fact that steels with body-centred atomic structure show about the same absolute increase of the yield strength for a given percentage area reduction. The effect of three variables can thus be combined in straight-line isometric graphs or simple models. It should be noted, however, that results derived from these graphs will only be approximate and that stray values must be expected. The averages have, therefore, always been taken fairly high, so that any derived values of power requirements will be fairly safe ones, unless, of course, the friction coefficient has increased for some reason or other, or the die angle differs considerably from the optimum.

Not only the available motor power, but also the maximum obtainable drawing force limit the capacity of a draw bench. From known formulae, the force can also be represented in graphs, and from a knowledge of force and power, the most economical working conditions can thus be easily established for existing benches of given maximum force, motor power, and gear box speeds. In many cases, infinitely variable gears will be found to improve working economy.

PUMPS

Corrosion-Erosion of Boiler Feed Pumps and Regulating Valves at Marysville, Second Test Program

By J. M. DECKER, H. A. WAGNER, and J. C. MARSH. (From *Transactions of the American Society of Mechanical Engineers*, Vol. 72, No. 1, January, 1950, pp. 19-26, 10 illustrations.)

THE rate of corrosion-erosion attack on carbon steels decreased with increase in temperature of the feed water, whereas the rate of attack increased for chromium-iron alloys. There is some indication that attack of the chromium alloys is greatest at some point between 250° F and 385° F. At all temperatures at which tests were made, the chromium alloys were much more resistant to corrosion-erosion attack than cast carbon steel.

1·25 per cent Cr, 0·5 per cent Mo steel and Cr-Ni-Mo steel were not attacked to a significantly greater extent than the 5 and 12 per cent Cr steels at the higher temperatures. Because of greater weldability and lower cost, it appears that the low-chromium alloys might be used advantageously in feed water having similar or less corrosive characteristics than that at Marysville.

Leaded bronze is not a good material for use at 250° F to 400° F under conditions where corrosion-erosion attack can be expected. "Navy M" bronze is satisfactory up to 320° F.

Chromium plating as a means of protecting existing carbon-steel pump casings is not satisfactory.

The authors have not been able to deduce the underlying causes for corrosion-erosion attack, nor to determine which of the many variables is the most important. Increasing the pH of feed water at Marysville from about 7·6 to 8·4, however, approximately doubled the rate at which cast carbon steel was attacked. This indicated that, for the Marysville feed water, the lower pH is more desirable. While in some quarters higher pH values have been advocated as a panacea for all corrosion-erosion troubles, these results would seem to indicate that some caution should be exercised in increasing pH of feed water indiscriminately.

DESIGN TRENDS AND THE STYLE OF MACHINE TOOLS

(*Continued from page* 136)

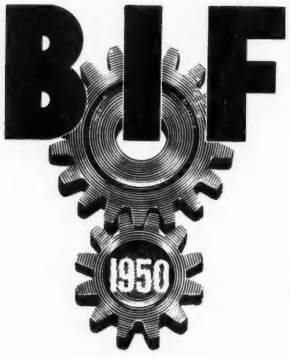
at the appropriate moment in the grinding cycle the cylinder *B* is set in motion, operating the pusher *C*, which advances a piece onto the workplate between the wheels and then withdraws. Regulating wheel and piece are then automatically advanced onto the opposing grinding wheel, the piece is ground, and as the wheels again open, the finish-ground piece is allowed to fall between the workplate and the regulating wheel. This simple method of getting rid of the ground piece, incidentally, is only rendered possible by the controlled-cycle method, which permits the withdrawal of any regulating wheel up to 1 in., in place of the restricted withdrawal of $\frac{1}{8}$ in. to which the older type of hand-operated centreless machine is limited, under which conditions the ejection of such a piece would be a somewhat difficult matter.

The second stage to be considered in the automatic loading of slender wire work of this description is the method of ensuring that a fresh piece is aligned and presented to the path of the pusher every six seconds. For this purpose, a V-shaped magazine or hopper is employed, as shown in elevation by the second part of the diagram. Underneath this is an oscillating selector which, under the influence of the roller *D* acting upon the suitably profiled cam *E*, is swung sideways at each stroke of the pusher gear until the groove picks up a piece from the hopper, after which the shape of the cam and the action of the spring permits a quick and smooth return to the upright position, where the piece selected is presented to the pusher on its next advance. Automatic production at rates up to 1200 needles per hour is obtainable with this equipment, according to the design of the piece in question.

(*To be continued.*)

BIBLIOGRAPHY

(26) E. J. TANGERMAN: Back to Cams again! *American Machinist*, June 2, 1949, p. 105.



MAY 8-19

Britain has invited the World!

Preparations for this year's British Industries Fair began before B.I.F. closed in 1949. To build up the greatest commercial event of 1950 organization has been continuous.

DURING THE SUMMER
3,050 manufacturers applied for a million square feet of display space. Exhibitors in 90 trades were allocated to 32 groups of allied industries.

IN AUTUMN
120,000 buyers throughout the world began to receive personal invitations.

THROUGH THE WINTER
63 advertising campaigns were launched in 33 languages—and a special campaign was prepared in America.

IN THE NEW YEAR
27,000 advance* catalogues were sent exclusively to buyers abroad.

BY SPRINGTIME
10,000,000 pieces of printed information had been distributed within business communities overseas.

NOW—some 15,000 importers are travelling here to see what we can make.

Will you be there?

LONDON—EARLS COURT AND OLYMPIA. Weekdays 9.30 a.m.—6 p.m. Buyers Badges and *Catalogues, 2/6 each, obtainable only at Fair. Public admitted Saturday & Wednesday (May 13 & 17) 1/6 each building.

BIRMINGHAM—CASTLE BROMWICH. Weekdays 9.30 a.m.—6 p.m. Buyers Badges and *Catalogues 2/6 each, obtainable only at Fair. Public admitted daily from 2 p.m. (all day Saturday) 2/6.

ENGINEERING AT CASTLE BROMWICH

BRITISH INDUSTRIES FAIR 1950

BIF 1950

MAY 8-19

The 29th British Industries Fair will take place from May 8-19, 1950, simultaneously at Olympia and Earls Court, in London and at Castle Bromwich, Birmingham. The Engineering and Hardware sections will be housed, as in previous years, at Castle Bromwich, Birmingham. Other sections, covering chemicals, scientific instruments, optical and photographic goods, radio, office appliances, plastics, textiles and domestic appliances, will be seen at Olympia and Earls Court in London.

An important feature at the Fair will be the participation of the Economic Co-operation Administration Mission to the United Kingdom jointly with the U.S. Department of Commerce. The E.C.A. is the United States agency entrusted with the responsibility of administering the Marshall Aid programme, and assisting the recipients in their dollar export drive. Commercial information bureau installed by E.C.A. will be found at all three sections of the Fair conveniently situated near the Board of Trade's commercial information bureaux. Since the end of the Second World War, many of the established trade fairs have notably expanded and new organizations have come or are coming into being in Canada and the United States. According to R. E. J. Moore, C.B.E., Director of the British Industries Fair, there is little evidence that support for the " Spring Fairs " would, in face of so much competition, weaken. In contrary, several of the fairs have gone from strength to strength, and all evidence indicates that Trade Fairs in various forms will continue to play a lively part in international commerce.

In the limited space we can devote to the B.I.F., we have been able to bring only brief description of a small number of exhibits. It is hoped that a large number of home and overseas engineers will visit the Exhibition who are offered an unique opportunity to view the latest developments in materials and finished products.

The B.I.P. Group, comprising B.I.P. Tools Ltd., The Streetly Manufacturing Co., Ltd., B.I.P. Engineering Ltd., and Beetle Bond Ltd., will stress in their display the versatility and technical skill offered by the Group.

B.I.P. Engineering Ltd. will demonstrate the making of typical trade moulding on one of the first production models of their moulding presses, which are equipped with automatic control of the moulding cycle.

Beetle Bond Ltd. will exhibit Beetle Resin W.20 used for bonding foundry sand cores and Beetle adhesives for the plywood and woodworking industries. B.I.P. Tools Ltd. will be demonstrating for the first time an induction-heated tool under working conditions. Another exhibit will be devoted to precision casting and will show the various stages in precision casting and a number of precision cast mould parts. In addition, examples of cold hobbing and examples of precision made mould parts will be shown.

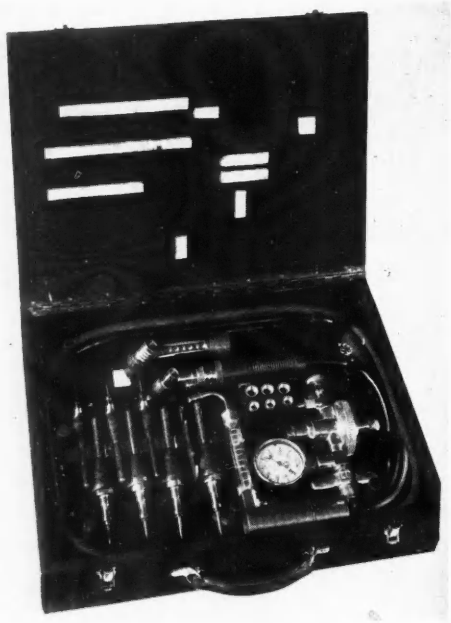
The Streetly Manufacturing Co., Ltd., will feature in detail the many components of the Remington Shaver made for Remington Rand Ltd. Another panel displays the various stages in moulding and assembling the G.P.O. terminal strip which is 5¼ in. long and comprises no less than 225 parts, including 44 moulded parts.

The British Oxygen Co., Ltd., will be exhibiting Oxy-Acetylene welding, cutting, and allied equipment, the main attraction will be the Argonarc Welding Process—to be symbolized by a rotating centre-piece in the form of a large stainless steel cube fabricated by Argonarc Welding.

The Argonarc Process, developed in this country by The British Oxygen Co., Ltd., is rapidly attaining paramount importance in industries concerned with the fabrication by welding of stainless steel, aluminium, magnesium, copper, nickel and their respective alloys. It is the only known method of fusion welding aluminium and other light alloys without the necessity of using a corrosive type of flux, thus eliminating the costly and often complicated methods of flux removal.

Demonstrations of Manual Argonarc Welding will be given throughout the period of the Exhibition. Equipment to be demonstrated will include the Mark II Torch for light gauge work and the Mark III Water Cooled Torch which permits metals up to ⅜ in. in thickness to be welded in a single pass. These torches will be used, in the case of Alternating Current in conjunction with the latest type of B.O.C. 300 amp. Composite Power Unit, incorporating a special welding transformer ; high frequency ioniser; D.C. Suppressor; power factor correction condenser, etc. Since the welding of certain metals, i.e. copper, is best carried out using Direct Current, a D.C. Motor Generator Plant will be used to demonstrate the Argonarc Welding of such metals.

Machine Argonarc Welding will be covered by exhibiting the latest type of Mark IV Argonarc portable welding machine. This machine has been designed to meet the need of high speed continuous welds in light gauge materials and, from the point of view of mass production of stainless steel, aluminium, magnesium and other metal products, is worthy of special attention.



B.O.C. Argonarc Equipment Mark II.

Oxy-Acetylene Welding. Demonstrations will be given of the welding of ferrous and non-ferrous metals; repair of costings; aluminium; flame brazing and lead burning, etc. Exhibits under this section will include the well known range of the Company's D.H. and C.H. blowpipes and also the latest type of Cutogen No. 4—Combined Welding and Curting Outfit.

Oxygen Cutting Machines. Demonstrations will also be given of various types of the Company's oxygen cutting machines including the 55 in. and 36 in. Universal Machines for intricate profiling work; Portable Straight Line and Circle Cutting Machine, and also the latest type of Plate Edge Preparation Machine which is specially designed for preparing the more complicated types of bevel edge preparations required for modern welding technique.

In addition, static exhibits under this section will include the latest type of Powder Cutting equipment for the cutting of stainless steel and certain non-ferrous metals, whilst a number of samples of the materials which have been cut by this new process will be available for inspection.

The British Thomson-Houston Company is exhibiting electrical power and lighting equipment at Castle Bromwich, Birmingham; and sound-film projectors, and Mazda lamps for photographic purposes, at Olympia, London.

The exhibits include a number of working demonstrations. The Stand design incorporates large photographs of heavy electrical plant, together with photographs, dioramic panels, and exhibits of Mazda lamps and lighting equipment. Particularly attractive, decorative lighting displays provide another feature of the Stand.

This presentation, together with a scale model of a 275-kV power transformer being constructed for the Staythorpe generating station, is a reminder of the wide range of products for which B.T.H. is renowned the world over.

Switchgear. A working exhibit is an 11-kV, 150-MVA, double-busbar, solenoid-operated equipment, as developed by B.T.H. for power station, substation and industrial use, and installed in many parts of the world. This exhibit is arranged for operation with three sections of a B.T.H. control panel of miniature design. A special demonstration panel enables visitors to see the operation of the control panel and switchgear under actual working and typical fault conditions.

Mining Equipment. B.T.H. has available an extensive range of standard flameproof apparatus. A working demonstration comprises a flameproof switch-unit for the isolation and protection of the feeder cable, and a gate-end box controlling a totally-enclosed fan-cooled flameproof induction motor. A flameproof push-pull start and stop switch enables the gate-end box to be operated from a remote point, if desired, such as at the loading point of the conveyor.

Flameproof Contactor Unit. 3·3 kV. This air-break contactor control unit has been developed by B.T.H. to meet the need for a compact equipment to control the stator circuits of high-voltage motors, installed where flameproof enclosure is necessary, and which are subject to frequent starting, and/or reversal. Applications include haulages and trunk conveyors in mines and also group motor control in refineries and other hazardous locations, both as direct-on-line starters for squirrel-cage machines and also for stator switching (in conjunction with suitable rotor controls) of slipring machines.

These new control units are suitable for motors up to 330 hp.

Electric Traction Equipment. This exhibit comprises a complete traction control unit of the latest type of PCM equipment (as supplied to London Transport) arranged to control a model electric train.

A.C. Commutator Motors. Two variable speed 400-volt, three-phase A.C. commutator motors are working exhibits. One is of 2½ hp with speed range 3,000 rpm to standstill, the other being of 7½ hp with speed range 1,450 rpm to standstill. The first has hand-operated brushgear. The smooth speed change is demonstrated by electric tachometer and voltmeter. The second machine is fitted with a stroboscopic disc to show the smooth acceleration and deceleration over the entire speed range; this machine has the latest type of pilot motor-operated brushgear.

Industrial Motors. Exhibits include typical four- and six-pole A.C. commutator motors; three-phase induction motors; stator and rotor units for building into machine tools; a totally-enclosed D.C. motor, developed especially to withstand the arduous duties encountered in steel works; and a typical spring-mounted loom motor.

Squirrel-Cage Induction Motors. Some of the smaller motors in the range from ¼ hp to 40 hp are shown by machines with cast iron frames and endshields together with machines of the same ratings with the latest die-cast frames and endshields.

Stator and Rotor Units. A unit consists of a wound stator in steel sheel (suitable for building into machine-tool makers' own frames) together with a centrifugally-cast aluminium squirrel-cage rotor for mounting directly on the machine-tool spindle.

These units are made in a wide variety of sizes from $^{1}/_{10}$ hp upwards, and normal 50-cycle speeds up to 3,000 rpm. Speeds up to 24,000 rpm can be obtained by the use of suitable frequency changers, and still higher speeds than these can be obtained by the use of inductor-type alternators.

Low-Speed Motor Units. B.T.H. low-speed motor units constitute a complete line of highly efficient machines, each built as an integral unit, for either A.C. or D.C. circuits, and for horizontal mounting. The motor is carried on the gear-box—an arrangement

permitting the use of gears and shafts of generous dimensions.

Fractional Horsepower Motors. A new flameproof petrol pump motor, as well as various totally-enclosed fan-cooled machines are among the many different types, sizes, and mountings exhibited.

Light Power Motors. Small motors that fall in this group are in great demand for many applications ranging from hair-dryers to floor-polishers and office machinery. They are built with the same care and attention to detail that characterize the larger machines in the fractional horsepower group.

Argon welded strator/rotor units for sealed-in refrigerator compressors form another interesting line to be seen on the Stand.

Fractional Horsepower Geared Motor Units. Geared motor units are now used extensively for a wide variety of applications ranging from mixers for food manufacture to driving light conveyors. The output speed can usually be selected to give the required speed for direct coupling to the driven shaft with no further reduction by pulleys and belts.

Suds Pumps. Designed for use with machine tools, these self-contained centrifugal pumps are for pumping suds or other liquids having a viscosity not exceeding 50 Redwood-seconds. Pumps can, however, be supplied with a modified impeller for pumping liquids with a viscosity in excess of this figure.

The pumps have no suction lift but are designed for immersion in the liquid up to the vent hole in the stem; the very stiff impeller shaft obviates the need for a bottom submerged bearing. They can be supplied for use on A.C. up to 550 volts and on D.C. up to 500 volts, the motors being totally-enclosed to protect the windings from dirt and suds. Outputs range from 5 to 24 gallons per minute against heads of 7 ft and 18 ft respectively.

Electro-Hydraulic Thrustors. Designed to exert a smooth straight-line constant pressure thrust, these devices are made in sizes from 40-lb thrust through a 2-in. stroke to 800-lb thrust through a 12-in. stroke. Flame-proof types can also be supplied.

Electric Control Gear. Several items of industrial control gear are shown as static exhibits, whilst some are used to operate other working demonstrations. The static exhibits include many well-known types of A.C. direct-on contractor starters for reversing and non-reversing squirrel-cage induction motors; push-button switches; and an automatic pressure switch for A.C. or D.C. circuits that is suitable for pressures up to 2,000 lb/sq in.

Industrial Heating. The "Pyrobar" heating element, which is readily adaptable and easily applied, offers a safe and convenient method of heating by electricity. It consists of a resistance spiral solidly embedded in magnesium oxide and protected from mechanical damage by an outer sheathing. The magnesium oxide is a good electrical insulator, and yet at the same time, owing to its compactness it affords excellent thermal conductivity.

For most applications, the heaters are suitable for direct immersion into liquids and soft metals where chemical action does not effect the tube. "Pyrobar" heaters cover a range of temperatures up to 900° C, and typical units for a wide variety of applications are exhibited.

Photo-Electric Control. Photo-electric relays can be used for a wide variety of applications in every branch of industry, ranging from the simple "counting" of articles on a moving conveyor to the more elaborate control of register of wrapping and packing machines.

The equipment exhibited is for two-way register control of a pre-printed web of material and consists of a scanning head, housing the photo-cell and amplifier; a thyratron control panel; and a rotary selector switch which is necessary to differentiate between a retarded feed or one that is too far advanced.

"*Emotrol.*" This exhibit consists of a standard B.T.H. "Emotrol" panel; a 15-hp, D.C. motor (running light); and a control station with "Stop," "Inch," "Crawl" and "Run" push-buttons, and a speed-control rheostat. A stroboscopic disc fitted to the end of the motor half-coupling provides a ready means of observing the speed-holding qualities and smoothness of speed-change of the equipment.

Electric Tachometer Equipments. These speed indicating equipments consist essentially of a generator unit, either A.C. or D.C. depending upon the type most suited to the application, and a high-grade voltmeter calibrated in revolutions per minute, miles per hour, or other suitable units. As no mechanical drive is required between the generator and meter, the latter can be mounted in a convenient position any reasonable distance from the generator.

Lamps. A novel "pillar of light" on the B.T.H. stand is constructed of an assembly of Mazda Fluorescent Lamps in various sizes and colours—"Daylight," "Natural" and "Warm-white." Also incorporated in this feature is the recently developed "Mazda-Mellow" lamp seen at the B.I.F. for the first time.

New 40-watt Mazda Instant Start Fluorescent Lamps are also shown for the first time.

Apart from fluorescent tubes there is a comprehensive array of many other types of lamps.

Lighting Fittings. Four fluorescent lamp fittings are shown, two of which are arranged on starter switch controlled circuits and the other two on instant start circuits.

In another part of the stand a series of dioramic panels show miniature models of typical installations of fluorescent lighting as applied to Mines (Coal Face), Department Stores, Streets and Factories.

One other special feature may be mentioned. This is a display of the principle involved in the installation of a specially designed lighting scheme for a large automobile manufacturing concern. The display shows how complete flexibility is achieved as to the type, wattage and positioning of the lighting equipment, and how provision is made for carrying equipment for a variety of other services necessary for factory operations, such as telephones, fire alarms, loudspeakers, clocks, etc., all within the same channel. This principle, described as Mazda Universal Lighting Trunking, is expected to find considerable favour for large scale complete installations.

Mazda Lamps used in taking photographs and moving pictures, and those used in projector work, are also displayed.

The former include flash discharge tubes giving a flash of light of high intensity and short duration; the midget ("No. 5") and S.M. photoflash lamps which give adequate light for general indoor flash photography; photoflood lamps, for the provision of a large amount of light of high photographic efficiency for low current consumption; the photopearl lamp, having a specially designed filament and bulb finish; and the reflector spotlight, with light output concentrated into a narrow beam for lighting photographic subjects.

The Mazda Projector Lamps, too, are in various types and wattages for specialized applications from the 1000 watt prefocus lamp for cinema projectors to low voltage lamps for micro-projection. Exciter lamps for sound film reproduction are also shown, and the compact source lamp, a high pressure mercury vapour lamp which burns steadily at high brightness. It has a quartz bulb mounted in a metal case with a window, and is also fitted with a prefocus base.

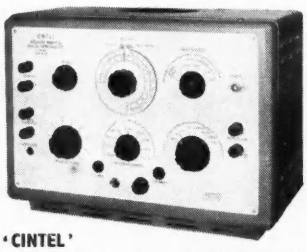
CINTEL

BIF 1950

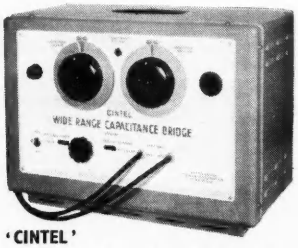
MAY 8-19

You are cordially invited to Stand No. **C16** in the Grand Hall, Olympia, where a new range of **'CINTEL' ELECTRONIC EQUIPMENT** will be presented.

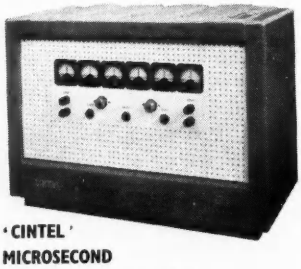
NEW EQUIPMENT INCLUDES:—



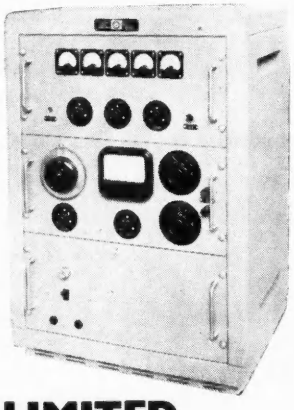
'CINTEL'
SQUARE WAVE & PULSE GENERATOR



'CINTEL'
WIDE RANGE CAPACITANCE BRIDGE



'CINTEL'
MICROSECOND
COUNTER CHRONOMETER



'CINTEL'
R.C. OSCILLATOR &
FREQUENCY MONITOR

CINEMA-TELEVISION LIMITED

A Company within the J. Arthur Rank Organisation

FOREMOST IN THE MANUFACTURE OF

• Counters & Chronometers • Metal Detectors • Oscilloscopes • Photo-Electric Cells • Cathode Ray Tubes • Geiger-Muller Tubes • Electronic Instruments

WORSLEY BRIDGE ROAD · LONDON · S·E·26

Telephone: HITher Green 4600

Northern Agents:
F. C. ROBINSON & PARTNERS LTD.
287 Deansgate, Manchester 3

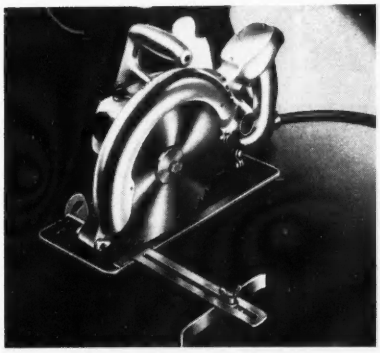
Scottish Agents:
ATKINS, ROBERTSON & WHITEFORD LTD
100 Torrisdale Street, Glasgow. S.2

CINTEL

REGISTERED TRADE MARK

Black & Decker Ltd. will exhibit electric drills, portable and bench grinders, portable electric hammers and their 16 gauge Lectro-Shear, the switch handle of which is now extended from the back of the tool over the top of the field case to bring the hand more nearly over the point of cut.

Also exhibited will be the " Ripsnorter " saws designed primarily for woodworking. They are now capable of cutting a wide variety of materials. There is a fine tooth blade for cutting all non-ferrous metals in sheet or extruded form, and a friction blade for cutting corrugated iron. The saw can also be provided with an abrasive disc. A 9 in. " Ripsnorter " saw is shown in the illustration.



Cinema-Television Ltd. will show at Olympia, London, a new range of portable Metal Detectors for the first time. The standard model for general use—timber yards, gas and water undertakings, etc.—now incorporates a 50 cycle noise suppression filter. This is essential when tracing metal which is situated near power cables. Another model is used for detecting pipes and cables buried to a depth of 30 feet below the surface. A special veterinary model has also been produced incorporating an electronic stethoscope. The Industrial Electronic Metal Detector for locating minute pieces of ferrous or non-ferrous metal in foodstuffs, plastics, etc., will also be demonstrated.

Of the many instruments for research and laboratory use on show, three deserve special mention. The first is the Universal Valve Tester. This equipment will display on a cathode ray tube a family of Ia/Va curves for any type receiving valve. Curves for eleven different grid voltages are shown simultaneously and a calibration pattern is also displayed enabling the valve characteristics to be checked. Variable supplies are also provided enabling the Ia/Va curves for any receiving valve working under any condition to be seen. The second is an R.C. Oscillator with a frequency range of from 10c/s to 100,000c/s. The feature of this instrument is that the output frequency is measured by an automatic monitor and displayed on five panel meters each scaled from 0 to 9. The monitor continually samples the oscillator frequency and presents the exact value every 5 seconds.

The third is the Microsecond Counter Chronometer. This instrument will measure time in the range 1 us to 1 second and 10 us to 10 seconds with a very high degree of accuracy. It can also be used for high speed counting—the maximum counting rate being 1,000,000 per second—for delivering pulse trains, frequency division, frequency multiplication, etc.

Numerous other instruments including Oscilloscopes, Power Packs, Scalers, Bridges, Cathode Ray Tubes, etc., will also be shown.

Crofts (Engineers) Ltd., are showing a comprehensive display of Power Transmission Equipment.

Several interesting working exhibits can be electrically operated by visitors to the Stand. These include Crofts' latest design in Variable Speed Gears and Pulleys, Crofts Stoker Drive Gear Box, and various other complete Gear Units. Another working exhibit incorporates a series of standard and special products including " Airflex," Disc and Rim Clutches.

Crofts " Ritespeed " Geared Motor represents a new departure in Gear Unit design for a variety of applications. This new design facilitates changes over a wide range of speed selection, giving a range of up to 60 output speeds. The nett result of this unique arrangement is that from a very small stock of components, complete Geared Motors are immediately available. Such assembly re-arrangements can be effected by use of a spanner within a matter of minutes.

Crofts' " Radiation " Worm Gear Units (Loose Foot Type) for all powers up to 2 hp in a wide range of stock ratios will be on view. This neat hand-sized unit has been designed with interchangeable feet which permits mounting in either standard, vertical or inverted positions thus making a standard unit available for the widest possible range of applications.

A further range of small power units of conventional design are also displayed.

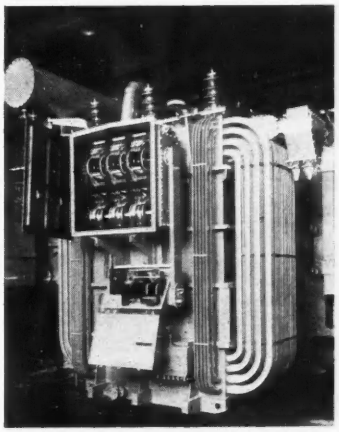
Crofts' Split Taper Adaptor Pulley is another development of considerable interest.

Crompton Parkinson Ltd. will be showing electrical machines, switchgear, electrical instruments, cables, lighting equipment and starter batteries. Electrical machines on show will include the Crompton 80 h.p. auto-synchronous motor ; the Crompton 50 kW D.C. Generator ; the Crompton 15 kW Alternator ; standard induction motors ; fractional horse power motors and ceiling fans. The Type MDA on-load transformer tap-changing switch, manufactured by the British Electric Transformer Co., Ltd., incorporating mercury switches, will be exhibited. This Mercury switch tap-changer fitted to a 5,000 kVA, 33/6·6 volt transformer is shown in our illustration.

The Nelson stud welding equipment which has found wide application in the metal-working industries will be demonstrated.

Instruments and Meters on exhibit will include " Tong-Test " ammeters for measuring both A.C. and D.C. amperes ; switchboard instruments ; portable instruments and house service meters. Portable instruments on show were designed for use in all climates. The resistance elements for voltmeters are enclosed in separate ventilated compartment so that the windings are cooled and the risk of " breathing " with subsequent condensation on the glass is reduced to a minimum.

Lighting equipment on exhibit will feature fluorescent lighting fittings.



BEETLE W.20

NEW CORE-BINDING RESIN NOW AVAILABLE FOR GENERAL PRODUCTION

Beetle W.20—the completely new core-binding resin—is already in use in the foundries. The testing-stage over, we are making deliveries in quantity for actual production work. Shown opposite are extracts from the data sheet of Beetle W.20:

Quicker stoving—considerable latitude in stoving temperatures is possible.

Good dry strength—green bond agents are easily added to impart the required green strength.

Knock-out properties exceptionally good.

Low viscosity—easy to handle.

Total gas evolution during pouring less than usual.

Odour reduced to a minimum.

Permeability of cores not affected.

All raw materials of W.20 are British — no supply difficulties—quick deliveries.

Conclusions:

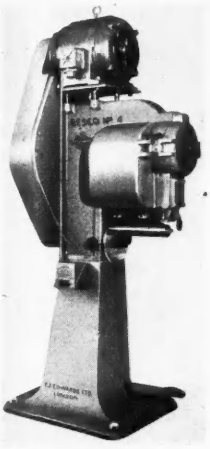
Beetle W.20 Core-binding resin can step up production and simplify the casting of intricately-cored parts. Not the least of its advantages is its all-British manufacture, ensuring promptness and continuity of supply at stable prices.

Write for Technical Leaflet C.B.1 to:—

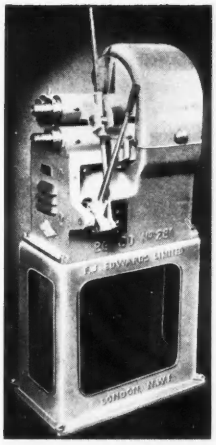
BEETLE BOND LTD., 1 Argyll Street, London, W.1

B·I·P GROUP

'BEETLE' is a trade mark registered in Great Britain and in most countries of the world



Side Seaming Machine.



Trimming and Beading Machine.

F. J. Edwards Ltd. will be showing the following eight new machines to be exhibited for the first time :—

" BESCO " Production Geared Guillotine for motor drive size 96/10, capacity 96 in. wide × $\frac{1}{8}$ in. thick mild steel.

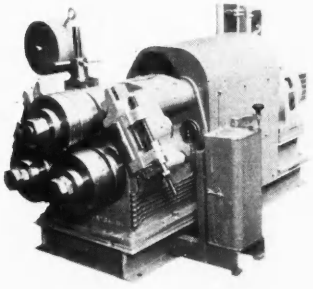
" BESCO " Nibbler-Shearing Machine, $\frac{1}{4}$ in. capacity mild steel.

" BESCO " Production Treadle Guillotine, of all steel construction, capacity 36 in. wide × 16 s.w.g. thick mild steel.

" BESCO " Production Bar Cropper, model BS60.

" BESCO " Open Fronted Vertical Section Rolling Machine, Model 1B.

" BESCO " Semi-Automatic Side Seaming Machine, Model No. 4, for side seaming tin box bodies or similar articles.



Open Fronted Vertical Section Rolling Machine.

" BESCO " Production Universal Rotary Combination Machines for hand operation. Suitable for swaging, wiring, jennying, trimming, circle cutting, etc.

" BESCO " Production " Simple Flanger " for flanging the edges of straight or irregular sheet metal blanks.

Firth Brown Tools Ltd. devised a novel design of stand consisting of a circular office round which the name style will slowly revolve.

Mounted on the transparent office windows—seven in all—will be a representative range of Firth Brown tools consisting of " Speedicut " Drills & Reamers, " Superleda " Butt Welded Lathe Tools, Ground Thread Taps and Chaser Dies, " Insto " Segmental Metal Cutting Saws, " Mitia " Carbide Lathe Tools and " Mitia " Carbide Tipped Saws, Slitting Saws, " Millenicut " & " Dreadnought " Milled Files, " Speedicut " & " Diehard " Hacksaws, Shear Blades and cutter block knives, and a typical selection of tools boxed in their colourful and modern packs for safety and ease of storage.

Of particular interest on the two " I. " shaped counters at the front of the stand, which will feature tools and give typical performance with examples of material cut, will be the small diameter reinforced shank drills down to ·004 " diameter. So small are these drills that they can be drilled through a small household pin. Examples of such drillings will be on display.

Testing the hardness of metals by means of the Firth Brown Variable Load and Fixed Load Machines and the effective metal removal properties of " Millenicut " and " Dreadnought " Milled Files will also be demonstrated.

The exhibit of **The General Electric Company Ltd.,** will be divided into three parts, displaying : (1) airport lighting equipment ; (2) street lighting equipment ; and (3) motors, motor control gear and accessories.

The main feature of the airport lighting display will be a working, scale model of part of an airport, completely equipped with airport lighting apparatus. Shown on the model will be a section of the instrument landing runway ; a complete approach lighting installation ; a taxiway ; a terminal area, and various auxiliary services, all complying with the recommendations recently agreed at the Aerodromes, Air Routes and Ground Aids Division meeting of the I.C.A.O.

Actual working examples of the various lighting units shown on the model will be displayed in addition

GEARED MOTORS
and
MOTORISED REDUCTION UNITS
¼ H.P. to 35 H.P. ALL VOLTAGES
VARIABLE SPEED UNITS FROM ¼ H.P. MINIMUM.

All Enquiries to
ELECTROPOWER GEARS LIMITED
KINGSBURY WORKS, KINGSBURY ROAD, LONDON, N.W.9
Telephone and Telegrams: COLINDALE 4621/2

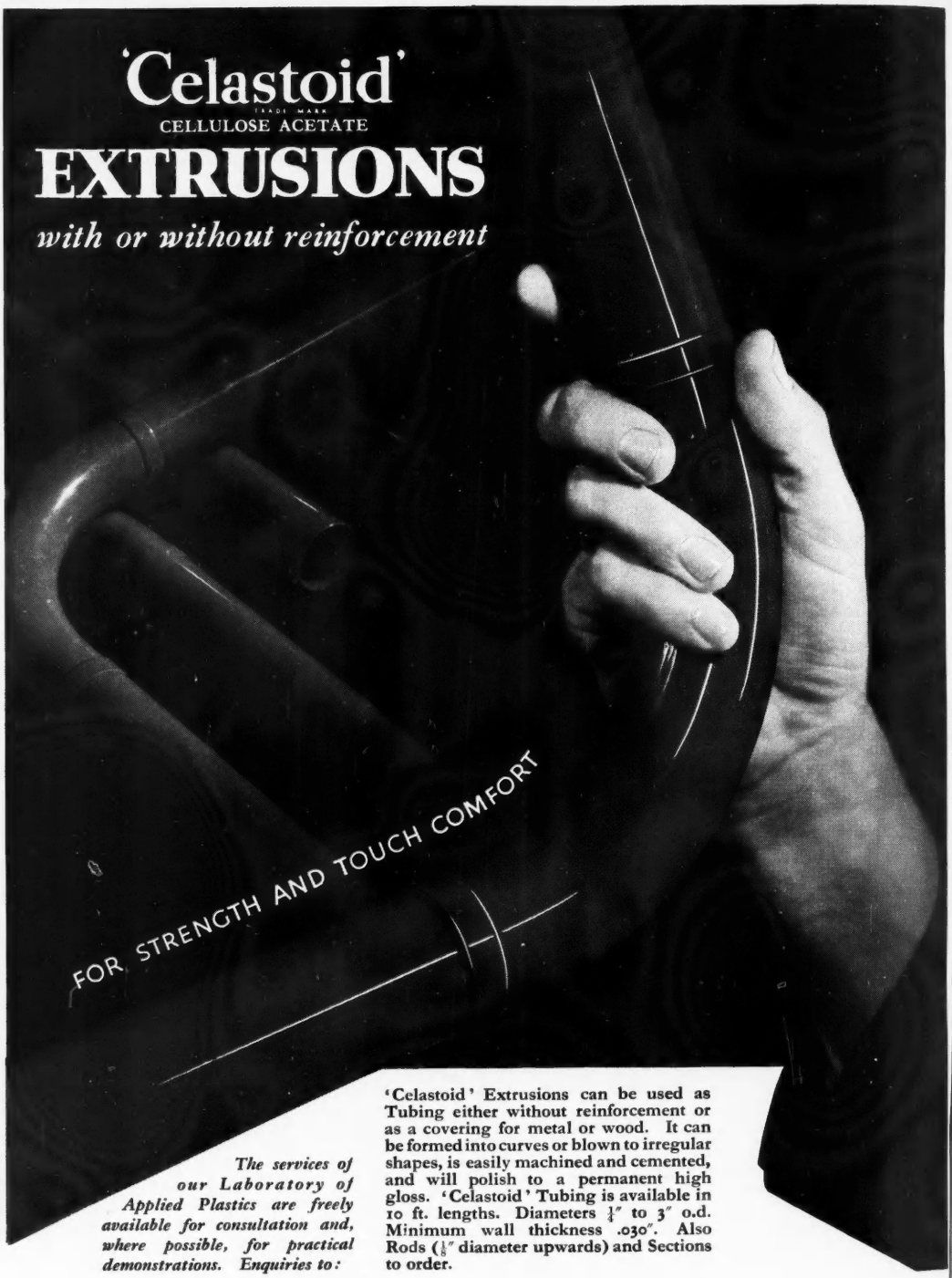
'Celastoid'

TRADE MARK

CELLULOSE ACETATE

EXTRUSIONS

with or without reinforcement



The services of our Laboratory of Applied Plastics are freely available for consultation and, where possible, for practical demonstrations. Enquiries to:

'Celastoid' Extrusions can be used as Tubing either without reinforcement or as a covering for metal or wood. It can be formed into curves or blown to irregular shapes, is easily machined and cemented, and will polish to a permanent high gloss. 'Celastoid' Tubing is available in 10 ft. lengths. Diameters ¼" to 3" o.d. Minimum wall thickness .030". Also Rods (⅛" diameter upwards) and Sections to order.

BRITISH CELANESE LIMITED

Plastics Division, Celanese House, Hanover Square, London, W.1

to lights designed for special applications. Also exhibited will be a selection of optical glassware made by the G.E.C. for use with G.E.C. airport lighting equipment.

To illustrate the application of its research facilities to the production of street lighting equipment, the G.E.C. will show stages in the evolution of a street lighting lantern, and the rigid tests made to ensure that no lantern goes into production until it is certain that it complies with sound engineering principles and will stand up to all types of weather and environments. The exhibit will include a " mock-up " of the G.E.C. " Dioptrion " lantern to show the care taken in its mechanical, optical and electrical design ; lanterns undergoing actual tests associated with lantern vibration and climatic conditions ; and photographs showing recent installations of G.E.C. street lighting equipment and the light distribution curves of the latest street lighting lanterns. In addition, samples of alloys will be shown to demonstrate the harmful effect of corrosion should the wrong type of alloy be used in a lantern's manufacture.

Street lanterns displayed will include the " Three-Eighty " refractor lantern ; the new Post Top mounting lantern ; a totally enclosed sodium lantern ; a " Viatron " lantern and a " Dioptrion," or double-dish lantern.

From the extensive range of the Company's motor production the G.E.C. will feature an impressive display of motors for the textile industry ; steelworks motors ; A.C. and D.C. industrial motors of all types ; motor starters ; and electronic equipment for motor control.

A complete range of squirrel cage loom motors from ½ hp-3 hp at 960 rpm will be on view. Important features of these motors are their interchangeability and high starting torque.

One of the most interesting items on show will be a special high torque motor designed to overcome the high inertia of carding engines on starting and, as a necessary part of the installation, a motor starter with distinctive characteristics. This control has design features which provide a high starting current for a period of up to 30/40 secs. to overcome the cylinder inertia while supplying normal overload protection during running.

Among the textile motors shown, will be the G.E.C. automatic ring spinning frame commutator motor with ratings of 6/12 hp, and 600/1,200 rpm.

A demonstration electronic motor control unit will be on view to illustrate the salient features of this form of control. Among its many advantages are :—

1. It is static ; 2. Responds much more quickly to its control circuits as compared with the field circuit of the equivalent Ward Leonard generator. 3. Requires considerably less control power ; 4. Speed control is continuously variable over a wide range 20·1 by armature control and as much as 60·1 by combined armature and field control ; 5. Its action can easily be made completely automatic ; 6. Full protection can be afforded against risk of sudden stalling of the motor.

The Metals Division of Imperial Chemical Industries Ltd., is staging a comprehensive display of its principal products—sheet, strip, tubes, rod, extrusions and wire, in copper, aluminium and their alloys.

A working laboratory unit shows how the Division employs spectrographic methods for the analytical control of its products. Photographs illustrate other specialized equipment used for research and control purposes.

Another feature is a half-section of a double purlin roof built up from channels, angles and corrugated sheet in aluminium alloys. This particular type of roof was designed for use in tropical climates, and can be adapted to any building structure, whether of brick, stone or mud. This exhibit also includes a profile section of a secret-fix type roof employing aluminium alloy sheet and extrusions.

Yet another display demonstrates, by model and photographs, the method of laying " Kuterlon " copper tubes for underground water supplies by means of the mole drainage plough. Incorporated in the display will be a specially drawn ¾ in. diameter " Kuterlon " tube 120 in. long.

I.C.I. Plastics Division will show at Earls Court the entire range of I.C.I. plastics, the emphasis being on major applications in the lighting and electrical fields and in the transportation, chemical, building, fancy goods and packaging industries. Demonstrations of the injection moulding of " Alkathene " will be given on the stand. A photographic feature will focus attention on the new phenolic powder plant at Wilton, the most modern of its kind in the world, which will be in full production later this year.

The Plastics Division stand at Birmingham will be of special interest to the engineering trade. Examples will be shown of engineering components moulded of nylon, polytetrafluorethylene gland packings and rigid polyvinyl chloride conduits and tank linings. " Alkathene " will be shown in various forms, including a new " Alkathene " foil for use as an anti-corrosion membrane for floors ; " Alkathene " tube for water service lines and " Alkathene " film for the protective packaging of tools and precision instruments.

The stand of the **I.C.I. General Chemicals Division** is devoted to the Division's Heat-Treatment Service for molten salt baths, and its comprehensive Metal Degreasing Service (which involves the use of trichlorethylene, alkalis and emulsions).

The wide range of uses of " Cassel " heat-treatment salts and furnaces is illustrated. A new, neutral heat-treatment salt is shown, for use in the range 720-950° C. This salt has the advantages of being readily soluble in water and non-decarburising under the most stringent conditions. Also on display is a standard " Cassel " salt bath furnace fitted with a new hand-operated transfer mechanism.

Several trichlorethylene degreasing plants are installed for normal working on the stand. They include an electrically heated vapour type plant, with a motor-operated pumping attachment of new design, and a totally enclosed continuous plant (with automatic ventilation) for degreasing small parts of intricate shape.

The Mavitta Drafting Machines Ltd. will exhibit four Drafting Machines mounted on Adjustable Drawing Stands. Their new adjustable Set Square and a selection of mathematical scales will also be shown.

The machines to be shown are the type A.1, which is available for covering boards up to 84 × 44 in. (110 cm × 210 cm), mounted on fully adjustable counter-balanced Drawing Stand. For horizontal use two machines mounted on light semi-adjustable tables will be shown.

Exhibited for the first time will be a machine that has been designed primarily for the production of full scale drawings. This machine consists of a travelling Drafting Head which is counter-balanced for easy vertical movement, and can be supplied to cover boards up to fifty feet in length.

The Morgan Crucible Co., Ltd., will display in the Refractories section the " Triangle " Refractory Concrete Mix 849, a material suitable for use at temperatures up to 1350 C, which may be cast into position like ordinary structural concrete. Pure Oxide Ware, a range of Firebricks and Assay Ware will be shown in this section.

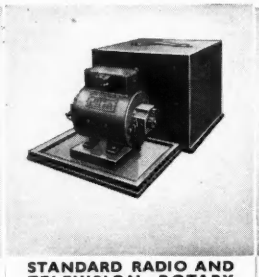
The Morgan Miniature Paraffin Crucible Furnace and the Morgan Crucible Heater will be exhibited.

A display of plumbago ware will feature many new products and applications in the foundry, metal melting and other heat using industries.

An extremely wide and varied range of anti-friction parts manufactured from Morganite materials will be

The AUTHORITY ON Power Equipment for RADIO & TELEVISION

LOW VOLTAGE ROTARY TRANSFORMER. 12 volts to 600 volts 200 m.a.



STANDARD RADIO AND TELEVISION ROTARY CONVERTER with filter and sound-proof cabinet. 230 volts A.C. Single Phase output.

MINIATURE ROTARY TRANSFORMER. 24/36 volts D.C. input. 60 watts output.

HIGH FREQUENCY MOTOR-ALTERNATOR. 200 watts 400 cycles output from 220 volts D.C.

For details and technical specification of Power Equipment for all Electronic purposes including the equipment illustrated, write for fully illustrated and descriptive lists 3 R.C. and 16 H.F. In prototype stages let your designers meet ours.

ELECTRO DYNAMIC CONSTRUCTION COMPANY LIMITED

Head Office and Works: ST. MARY CRAY · KENT

BRANCH WORKS: BRIDGWATER · SOMERSET

'Phone: Orpington 2560-3

included among the exhibits. Components on show will include Morganite Carbon Crane Current Collectors; Trolley Bus Collector Inserts; Morganite Carbon Seals which are entirely independent of external lubrication and are invaluable where high temperatures or immersion in liquids prohibit ordinary methods of lubrication; The Morganite Unite Seal for low pressure pumps; Carbon Valves and Slides for Gas Meters; Carbon Valves for Water and Petrol Meters; Carbon Gland Rings for Turbines and Compressors; Carbon Piston Rings; Carbon Welding Rods; Morganite Furnace Parts and Metallurgical Tubes and Boats and Morganite Carbon for the Glass Industry.

Morganite Self-lubricating Bearings will be shown in the full range from plain graphitic carbon with no metal inclusion to straight sintered metals containing no graphite, and with this range it is possible to deal with a wide variety of load, speed, temperature and chemical conditions.

A range of Morganite Brushes used all over the world on all patterns of industrial and fractional electrical machines will also be displayed.

A section of the stand will be devoted to a display of Carbinert (Impervious Graphite) and Carblox shapes for use in blast furnaces.

Morganite Resistors Ltd., subsidiary of The Morgan Crucible Co., Ltd., will exhibit carbon resistors, potentiometers, volume controls and interference suppressors manufactured at their new factory on the Bede Trading Estate at Jarrow.

Their well-known range of potentiometers has recently been extended by Type "A," which can be supplied either with or without switch. The switch, of an improved design, has successfully passed the stringent tests imposed by the leading Continental Electricity Authorities, including Sweden, Norway, Denmark, Finland, Switzerland, etc.

A midget potentiometer designed for hearing aids has now been further reduced in size, and can be supplied in colour to B.S.I. Colour Code specification. This DA control, can be made with or without a single pole switch and is already finding useful applications other than in hearing aids.

The range of fixed type carbon resistors has been simplified and concentrated into two types, "R" of 1 watt and "T" for all ½ and ¼ watt applications. These resistors, both of the axial wire types, can be supplied in the full range of preferred values, with tolerances of 20, 10 or 5 per cent.

For interference suppression of automobile ignition systems this Company offer Type C.1 for fitting into the H.T. cable lead, Type B.1 for fixing to plugs, screw terminal and Type B.3 for plug fitting with a push on terminal. In addition a new type D.1 for fitting into the central socket of distributors is likely to be available shortly. Resistance values of 5,000, 10,000 and 15,000 ohms can be supplied.

The Rapid Magnetting Machine Co., Ltd., will be exhibiting various types of their Specialized Magnetic (Electro and Permanent) Separators and Extractors, also Electro Lifting Magnets, Clutches, Brakes, etc.

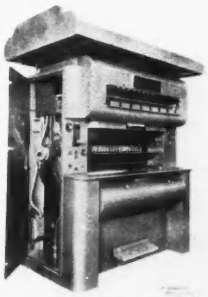
A new addition is the Crockett Patent Submerged Belt Type Magnetic Separator for the positive recovery and cleansing of mediums, i.e., Ferrosilicon and Magnetite as used in Heavy-Media Separation processes.

The "Rapid" Magnagrid, a new and patented device for insertion into feed hoppers, will be shown for the first time.

A novel Magnetic Floor Sweeper will also be displayed. This device will have numerous applications for the collection of Nails, Nuts, Bolts, and a miscellany of ferrous materials. No electrical connections are needed.

The "Rapid" Magnaclamp, a new device for workholding will be on view, also a simple Magnetic Drill Extractor for the recovery of valuable drills and broken bits.

The Ozalid Company Ltd. will be exhibiting four new Ozalid plan copying machines, each of which incorporates outstanding improvements.



The largest machine will give synchronised exposure, development, stacking of finished prints and originals in one continuous operation, at a speed range from zero to 30 feet per minute. The variable drive will be controlled by a Thymotrol electronic device. An entirely new developing machine of streamlined design, incorporating the latest ideas in ammonia development will be shown for the first time.

Sangamo Weston Ltd. will exhibit the HMT single-phase credit meter, the polyphase 2 element, and 3 element types, and the prepayment patterns available as multi-coin and fixed charge collectors. All single-phase meters are enclosed in bakelite housings and all types are temperature compensated. Portable rotating sub-standard meters for checking house service meters, together with instrument transformers and metering accessories, will also be exhibited.

A full range of small synchronous time switches will be shown. Switches are available in 5, 10 and 20

THORNTON'S
DRAWING
INSTRUMENTS
have been used by the Engineers responsible for the world's most famous constructions. The more important your work the greater the necessity for Reliable and Accurate Drawing Instruments. Illustrated catalogue sent post free on request.
PIC
SLIDE
RULES

A. G. THORNTON LTD
Drawing Instrument Specialists
WYTHENSHAWE, MANCHESTER
Tel: WYThenshawe 2277 (4 lines)

L7A

corrosion resisting

steel castings

by

HADFIELDS
SHEFFIELD

Send for Corrosion Resisting Steel Brochure No. 480

HADFIELDS LTD., EAST HECLA WORKS, SHEFFIELD, ENGLAND

ampere capacities and a day omitting device and manual operation button are standard fitments on most models.

Small synchronous motors designed to provide motive power for various a.c. timing mechanisms will be exhibited. These motors are available with or without gearing and can be supplied for either clockwise or anti-clockwise rotation for all commercial voltages and frequencies.

A representative range of Weston electrical instruments on show will include Laboratory Standards for measurements of extreme accuracy ; a Multi-Range Test Set; D.C. Galvanometers; Frequency Meters; Panel and Switchboard Instruments ; Photometers and Exposure Meters and a wide range of Aircraft Instruments.

Engineering exhibits of **Geo. Salter & Co.** will include Springs, made from a wide range of materials, Roller Bearings with flexible and Solid Rollers, and the No. 99 Crane Weighing Machine. This is available in capacities from 10 cwt. to 100 tons, with either hook or shackle fitments. Its uses include the weighing of loads as they are conveyed by crane from ship to dock, and lorry to warehouse, and weighing heavy machinery in transit, in engineering works. Another important use of the No. 99 is that it provides the easiest means of testing the load capacity of the crane itself, when the crane has a fixed jib. In the 100 ton size, the machine is claimed to be the largest capacity, portable, suspended weigher in the World.

The Shipston Engineering Co., Ltd., will be exhibiting the Sundstrand light weight portable Sander for wet and dry rubbing and finishing of wood, metal, plastic, or composition surfaces. The Norgren Oil Mist Lubricator, necessary to all pneumatic tools, will also be on show. Other exhibits will include the A.R.M. Balancer and Cimbal, the Norgren Moisture Trap, the Norgren Pressure Regulator and the Shipston Springmaker.

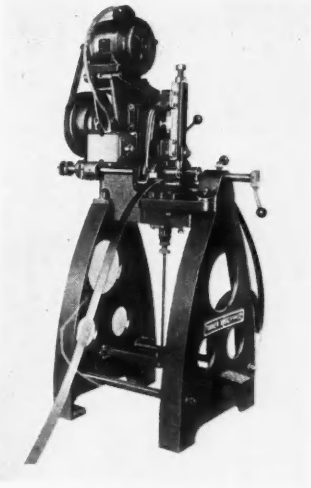
Turner Brothers (Birmingham) Ltd. will display a range of their well-known T.B. Power Presses including an Inclinable Press of six tons capacity, having a special type roll feed for producing can handles. The roll feed in this press is driven by a single chain.

Boyce Weavers Knotter.

An interesting exhibit will be the firm's new 15 ton geared Press.

On the Stand also will be a comprehensive range of pressings and die castings produced from press tools and moulds, and also a wide variety of plastic articles produced from moulds.

Also on view will be the Turner Taper Saw Toothing Machine. Introduced about a year ago, this machine has created considerable interest, and is designed to give maximum performance in the cutting of teeth on either parallel or taper saws, and is completely self-contained with its own stand and power unit.



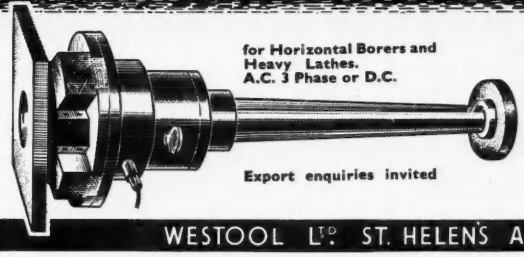
Saw Toothing Machine.

Of particular interest will be an exhibit of the Boyce Weavers Knotter for which Turner Brothers actually produced the tools twenty-two years ago. These tools have been working ever since on the Knotter, which includes parts in cast steel and stainless steel. The Boyce Weavers Knotter is one of the most ingenious machines ever invented and the makers, Messrs. Mellor Bromley & Co., Ltd., were well aware twenty-two years ago of the many difficulties to be overcome in the production of the tools.

The Wellington Tube Works Ltd. will be showing a selection of Tubes, Tubulars and Fittings, and a considerable range of products incorporating tubular construction. Successful application of tubular fabrication will be demonstrated in many exhibits amongst which a patented Handrailing Joint of exceptional efficiency and neatness is of particular interest. Examples of fabricated flanged pipework will be displayed, together with panels specially designed for panel heating and a representative selection of 1 in. to 4 in. mild steel Spiral Wound Gilled Tube. "Weldex" Heaters will be shown in capacities varying from a small Unit Heater to a heavy duty Plenum including a Gas-fired Unit Heater for space heating, and a selection of Convectors.

The display will include a wide range of Stampings manufactured by Job Edwards Ltd., Wednesbury, a subsidiary company of Wellington Tube Works Ltd.

The Westool Grinder (Type H.G.R.)



for Horizontal Borers and Heavy Lathes.
A.C. 3 Phase or D.C.

Export enquiries invited

WESTOOL

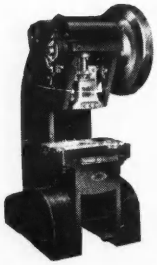
WESTOOL LTD. ST. HELENS AUCKLAND, CO. DURHAM PHONE WEST AUCKLAND 317

We rather care for FOREIGN VISITORS!

B.I.F. 1950
MAY 8-19
CASTLE BROMWICH
BIRMINGHAM
SEE OUR EXHIBIT
STAND
D 512

"It is impossible," said Mr. Turner, idly squaring a circle on his blotting pad, "to keep in constant touch with all our business friends. Our Sales Flags pepper the world . . . trained flag-stickers work day and night to keep up with our order books. But, at the British Industries Fair we can meet these friends face to face. Come and see us and tell us the one about the Englishman, the Irishman and the Scotsman . . . or if you prefer it, about the Zulu, the Maori, and the Venezuelan! It's all one to us . . . we've heard it, anyway!"

Power Presses from 6 to 75 tons capacity.



PRESS TOOLS
POWER PRESSES
JIGS & FIXTURES

MOULDS
SPECIAL PURPOSE
MACHINES

-all perfectly true!

One of the five well - equipped Turner Factories.

Turner BROTHERS (BIRMINGHAM) LTD.

GALVANIC WORKS, CLIVELAND STREET, BIRMINGHAM, 19
Telephone: ASTon Cross 1741 (5 lines)

THE LARGEST CONTRACT TOOLMAKERS IN THE WORLD

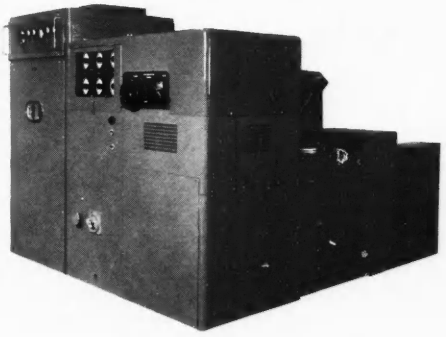
New Materials, Processes and Equipment

GEAR HARDENING EQUIPMENT

REDIFON LIMITED were recently approached by the Ford Motor Company to supply an Induction Hardening equipment for the production of starter ring gears. Their special requirements were as follows :—

To harden the teeth on three sizes of starter rings varying between 10·2 in. and 16·2 in. in diameter to approximately 0·1 in. below the roots, this depth to be controllable within limits ; to remove each of the rings from the quench bath at a predetermined rate so that they emerged at a temperature of approximately 200° C for stress relieving ; the equipment should be capable of being operated by unskilled labour ; change over from one size ring to another to be effected simply and rapidly. Coil changing to be carried out automatically within the machine ; and the rate of production to cover a total output of 900 small, 240 medium and 220 large rings per 18 hours.

The accompanying photograph shows the equipment which was finally developed. After a ring is placed in the circular locating frame at the loading station (middle right), the lid is closed and the subsequent sequence of operating events is entirely automatic.



The ring is passed to an hydraulically operated carriage which conveys it to a position immediately below the heating coils. Internally operated mechanical fingers then raise it from the carriage into the heating coil. The carriage then returns to the loading station and the lid opens ready for the next ring to be inserted at the operator's convenience.

When the ring is in position inside the heating coil, R.F. power is automatically applied. At Curie point a power-factor correction condenser is brought into the circuit to provide re-matching. On the completion of the heating cycle, the fingers release the ring so that it drops into the quench. A wire mesh conveyor then removes it from the water and delivers it to the ejection bay. The speed of the conveyor is regulated to ensure that the delivery temperature is of the order of 200° C.

Changing production from one size to another is an extremely simple operation occupying a matter of only 30 seconds. The lever on the front panel is put in the " Reset " position and the correct locating frame is placed in the loading station. The main control wheel is then turned to the appropriate position for " Small," " Medium " or " Large " rings and the lever reset to the " Ready " position. The conveyor speed control is then adjusted to the correct setting which is indicated by the lighting up of a neon lamp.

Circuit pre-selection and process timing are all automatic and are controlled by an interlocking switch circuit operated by contacts on the locating frame and on the control wheel. The system is foolproof and R.F. power cannot be applied until controls are properly matched and the correct size ring inserted. This is checked by pressing the " On " button when a blue lamp lights up indicating that the setting is correct and the hydraulic system is ready for operation.

BEARING SELECTIONAIRE FOR MATCHING RACES AND BALLS

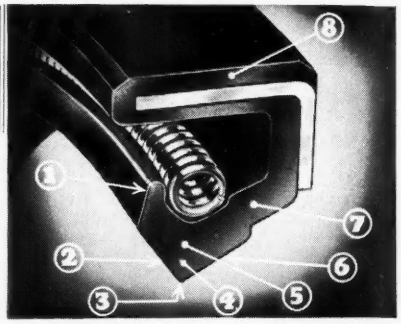
THE Sheffield Corporation of Dayton 1, Ohio, has developed an air-operated selectionaire for matching races and balls for bearing assemblies to automatically control radial play to any desired tolerance. It effects drastic reductions in the manufacturing costs of finished bearings.

Precise size, insofar as the diameter of the balls and of the outer and inner races are concerned, becomes extremely important when they are brought together as an assembly. The diameter of the inner race plus two ball diameters must very nearly equal the outer race diameter or the bearing will have too little or too much radial play.

It is common practice to accurately classify balls and inner and outer races in 0·010 in. steps, and maintain a considerable stock with many classifications of each of the three components until they can be brought together for assembly. Complete precision bearings require close inspection and careful selection. Assuming that inspection of the balls and races is 100 per cent accurate, it is still possible that the accumulation of allowable variations will result in an error amounting up to 0·0004 in. or more in the assembled bearing.

The solution of the radial play problem was the development of an instrument that *would tell before assembly* exactly how much space would be left between the inner and outer races for the balls. The Bearing Selectionaire is a process gauge as well as an inspection instrument. It may be used in any of the following

Foot pedal actuates device for equidistant spacing of spindles to simulate assembled bearing.



1. Deep rim affords perfect Spring Retention.
2. Large Face Angle brings Sealing Edge well below spring.
3. Knife Edge Contact at Sealing Point.
4. Sealing Point stiffened against local deformation by large included angle.
5. This section stiffened to prevent deformation under load.
6. Shaft angle gives adequate clearance.
7. Flexible Web.
8. Gaco Skin affords better fluid tight fit in housing.

"HAIRLINE" LIP CONTACT!

THE

GACO M.I. OIL SEAL

[British Patents 478136, 479743]

The Scientifically Designed Oil Seal which is now the accepted standard for Rotary Shaft Oil Retention. Made of GACO!

ANGUS OIL SEALS

Fluid Sealing Engineers

GACO

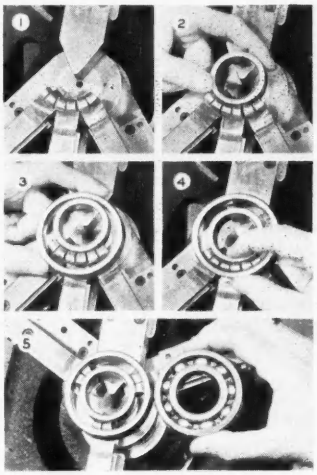
REGD. TRADE MARK

GEORGE ANGUS & Co LTD

OIL SEAL WORKS,

NEWCASTLE UPON TYNE, 6.

ways with accuracy heretofore unobtainable on a production basis.



1. As a matching gauge whereby inners and outers of nominal sizes, but unclassified as to actual deviation, are taken at random. The reading on the Selectionaire indicates the correct ball size which will give an assembly of predetermined radial play.
2. For selection of inner races to an outer race of known dimension or vice versa.
3. If the assembling process calls for selecting races to match a standard size ball, the inner races are first segregated by classification. An inner race of known size is then used on the Selectionaire to which the unknown outer race is compared. The resultant reading indicates the actual inner race that should be used for the particular outer race and standard size ball to make up the assembly.

With this new cost cutting method of assembly of balls and races, the operator can determine in advance or forecast any radial play tolerance. If present policy is to restrict the number of ball sizes, the maximum radial clearance precision is obtained by selection of matching races. However, if manufacturing emphasis is placed on limiting the number of ball race sizes, it permits quick selection of multi-size precision balls to match. Assembly time is cut to a fraction of that formerly required. Dismantling and rebuilding to obtain desired quality are practically eliminated and the entire assembly process is speeded up. The same principle promises to have a wide application wherever measurement or assembly of two, three or more unknowns are involved.

FLUSH RIVET MILLER

A NEW flush rivet miller with a 15,000 rpm pneumatic motor is announced by Aircraft Tools, Inc., 2306 East 38th Street, Los Angeles.

This rivet miller has the exhaust air silenced. Moreover, the exhaust air cools the motor and blows the chips away from the work.

For high precision rivet shaving, this tool is invaluable. It is short (overall length is five inches), well-balanced, light, and easy to control. Adjustable in increments of 0·0005, the rivet miller has the following special features :—

A positive adjustment lock collar ; an adjustable and removable pressure foot frame ; a footpiece which revolves by hand; a hard shore rubber foot that is screwed into position and is replaceable ; a pressure foot completely enclosed to seal lubrication and keep out chips ; and a matched pair of precision, pre-loaded bearings to support the cutter.

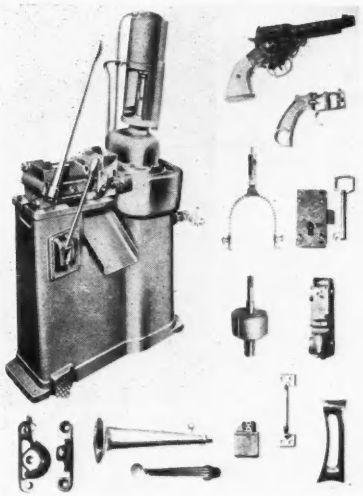
Cutters of this rivet miller are standard and interchangeable with most types on the market. No special tools are required for replacing them, and the unit can be dismantled in less than one minute.

Aircraft Tools' Micro Miller is available with cutter and skirt in the following sizes : 5/16, 3/8, 7/16, 1/2, 9/16, 5/8 and 3/4.

NEW SMALL HIGH-SPEED DIE CASTING MACHINE

A NEW one pound capacity zinc alloy high speed die casting machine has been developed by the DCMT Die Casting Machine Corporation, 164 Duane Street, New York 13, N.Y.

This die caster utilizes the new principle of fast chill and high cycling speed on low cost small single impression dies. Direct valving " explodes " air into the cylinder. This causes supersonic piston speed which " shoots " hot molten metal into the cavities before it has a chance to cool off, permitting a small water-cooled sprue which solidifies instantly, resulting in a high speed cycle.



An average production of 500-700 shots per hour can be maintained, and die sizes up to 6 in. × 9 in. can be used. Small prefabricated die blanks are supplied with the machine and cavities can be machined directly into these blanks. Even production runs as low as 2000 pieces have been found economical.

The exceptionally small size of the DCMT machine makes it usable in even the smallest plants. Floor space measures only 24 in. × 12 in., weight 470 lbs. Scrap loss, most secondary operations and finishing costs are eliminated. Everything but the product is remelted and re-used. Drilling, countersinking, etc., are all taken care of by the use of cores in the die. Satin-smooth die cast finish dispenses with grinding and most of the buffing and takes any painted or plated finish.

DOWTY
Bonded Seals

British Patent Nos. 537654 and 576233

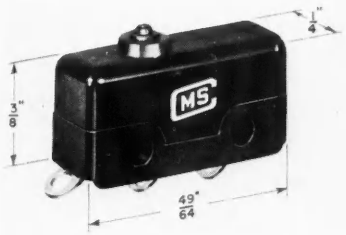
Foreign Patents pending.

DOWTY BONDED SEALS are simple to fit. The rubber washer bonded to the metal ring forms a faultless, leakproof seal when compressed within a joint. They can be used with liquid or gas for pressures up to 10,000 lbs. per square inch and are available in a full range of standard sizes.

DOWTY SEALS LIMITED, CHELTENHAM

NEW SUBMINIATURE PRECISION SWITCH

MICRO SWITCH, Freeport, Illinois announces a new subminiature plastic case switch measuring only 49/64 × 3/8 × 1/4 inch, less than 1/15th the volume and weight of the standard plastic-cased snap-action precision switch.



This new switch opens a new field of uses for snap-action precision switches, where installation space or weight are factors.

This thumb-nail size switch has a " Pin " plunger actuator, and circuit arrangement is single-pole, double-throw. Terminals are solder lug type.

Tentatively, characteristics are listed as follows :—

Operating Force	20 oz., maximum.
Release Force	2 oz., minimum.
Movement Differential	0·03 to 0·05 in.. approximately.
Pretravel	0·065 in., maximum
Overtravel	0·005 in., minimum

Electrical capacity tests indicate a rating of 5 amperes 115 to 230 volts, a-c ; and 2 amperes 28 volts, d-c.

METALOMETER

A NEW pocket-size surface hardness testing instrument has been introduced by Peabody Industries, Inc., 1863 Penobscot Building, Detroit 26, Michigan.

Today close quality control of materials is a must in industry. The Metalometer, of new patented design and precision-checked, brings quality control at a new low cost in the metal working industries.

Features of the new product are its low cost, accurate readings and simplicity in operation.

In operation, the instrument is placed on the surface to be checked, a hammer is released, and accurate readings are available in less than a second.

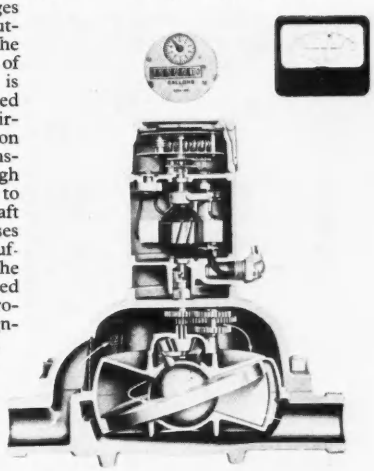
The Metalometer has been laboratory-tested for instant, accurate readings on any of the three standard scales—Brinell, Rockwell B and Rockwell C. Readings are guaranteed accurate well within commercial hardness limits. It is rugged, with no wearing parts that will affect accuracy of operation, and is designed to permit years of constant use. It will not mar the surface of work being tested—an important factor where costly dies, plated finishes, etc., are involved.

FLOW METER FOR CORROSIVE LIQUIDS

THE Hays Corporation announces a new Flow Meter and Veritrol for indicating and controlling the rate of flow of corrosive liquids. Examples of corrosive fluid which can now be handled are : Acetic Acid, Aluminium Potassium, Sulphate, Ammonia, Calcium Compounds, Carbolic Acid, Formaldehyde, Fruit and Vegetable Juices, Hydrogen Peroxide, Phosphoric Acid, Potassium Hydroxide and Sulphuric Acid (concentrated).

The Hays Veriflow Meter accurately measures the flow of almost any fluid without using weigh tanks, orifice plates, or gauge sticks. It indicates the rate of flow at all times, without interruption and at the same time registers every gallon.

Measurement is volumetric. Each complete movement of the measuring piston displaces a fixed volume of liquid (see illustration). The liquid enters through the inlet port and fills the spaces above and below the piston. The volume of liquid flowing in the annular space around the centre ball of the piston causes the piston to move with a " nutating " motion until the liquid discharges through the outlet port. The centre port of the piston is thereby caused to make a circular motion which is transmitted through a gear train to the drive shaft which passes through the stuffing box to the direct connected generator through a self-aligning coupling.



The rate of flow indicator (which can be mounted remote from the rest of the meter) measures the output of the generator and is calibrated to indicate the corresponding rate of liquid flow through the meter.

The Veritrol is a Veriflow Meter plus automatic control equipment. The out-put of the meter generator is measured by a contact-making relay which, through its contacts and reversing relays, operates a motor which, in turn, positions a control valve. This valve controls the rate of liquid flow through the meter until the generator output balances a potentiometer circuit at the rate of flow for which it has been manually set.

MIXED BED DEIONISATION

Eight years ago, under the stress and impetus of wartime demands, Permutit introduced a new technique in water treatment. This involved the use of mixed cation and anion exchange materials for producing high quality demineralised water in a single step.

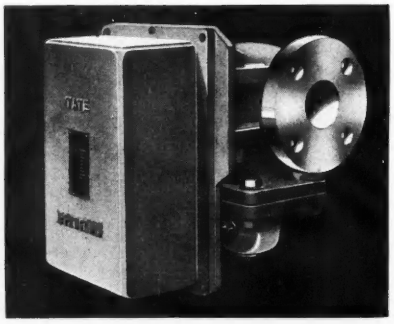
Since developed and adapted to peaceful needs, this Permutit treatment now offers tremendous possibilities for industry. It makes possible the production of extremely pure water in a single treatment stop : water with an electrical resistance of over 10 million ohms per cubic centimetre.

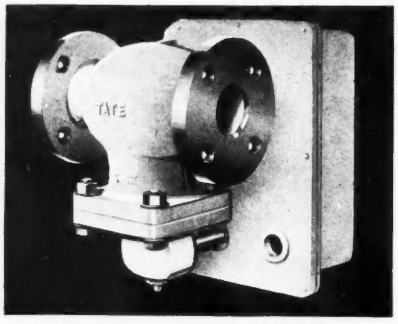
The ion exchange materials employed in this mixed bed deionisation technique are " Zeo-Karb " 315 and the newly developed highly basic anion exchanger " De-Acidite " F. When a mixed bed is used for treatment of water which has been previously distilled or demineralised by a normal technique, the effluent from it is of a quality previously unobtainable without multiple distillation and is suitable for use as conductivity water and in trace element work.

A further advantage of this method of treatment for solutions is that deionisation takes place in neutral solution with the result that acid sensitive solutions, e.g. blood plasma or sugars which are liable to inversion and mutarotation, can be treated. Known as " Bio-Deminrolit," the mixed ion exchange material is finding an increasing number of uses.

TATE

SOLENOID OPERATED SEMI-BALANCED DC VALVES AC





For use on

STEAM, WATER, AIR, GAS, SPIRITS, OIL, CHEMICALS, ETC.

SIZES: ¼", ⅜", 1", 1½", 2", 3", & 4"

Pressure Range: 5 lbs □" to 200 lbs □"

JONES, TATE & CO. LTD.

VICTORY WORKS

BRADFORD

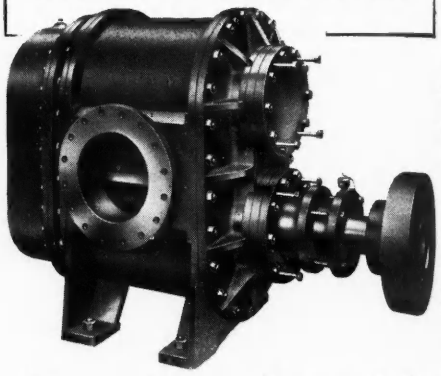
*'PHONE: 28348/9 *'GRAMS: VALVE.

DRUM ROTARY PISTON PUMP

Viscous as molasses or mobile as spirit..

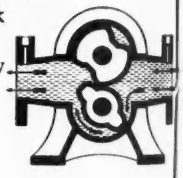
from 150-250,000

GALLONS PER HOUR



'Drum Pumps' can do it

A consideration of the following points will show why "DRUM" Pumps are continually being called upon to meet so many different needs, in all branches of industrial pumping:—



- Will pump thin or thick liquids.
- Suitable for high or low speeds.
- Positive action.
- Continuous flow.
- Can be steam-jacketed.
- Valveless and no air vessels.
- Rugged construction.

The diagram shows how a continuous flow is obtained by the action of the revolving piston. Amongst other advantages, this preserves the equilibrium of emulsions or suspensions.

ALL ENQUIRIES TO:

The Drum Engineering Co. Ltd.

HUMBOLDT STREET, BRADFORD.

LONDON OFFICE: 38, VICTORIA STREET, WESTMINSTER, S.W.1

TELEPHONE: ABBEY 3961

THE PHYSICAL SOCIETY'S EXHIBITION

The Physical Society's Exhibition at the Imperial College, London, provided a most impressive display of scientific instruments. The displays included instruments of commerical firms and research exhibits by Government departments, universities and other research bodies.

Designs incorporating all the best features of post war scientific research indicated a return to the close collaboration between the instrument maker and the academic scientist. With a freer hand than scientists in commerical firms, workers in universities and Government departments have displayed instruments using a wealth of new techniques, and many ingenious solutions to long-standing problems could be seen.

While it is not easy to pick out particular instruments in a show which comprises nearly all stars, great interest was stimulated by the complete automatic pilot which was exhibited. The continuing development in the study of atomic energy was demonstrated by the large amount of apparatus on show in this field. Many of these instruments, necessarily delicate in their construction, now appear in robust and portable form indicating the likely future development of the application of radioactive techniques to the solution of large numbers of industrial problems.

A feature worthy of note is the increasing use of physical methods for the solution of problems previously solved by chemical or other means. It is true that there has been in the last decade a trend towards an enormously increased influence of physics on industry, and it would seem likely that physical methods will play an ever growing part in the technology of the future.

A complete guide containing detailed descriptions of the exhibits was published by the Physical Society at 1 Lowther Gardens, London, S.W.7. We shall give, however, a brief survey of some important displays, including a selection of books on various branches of physics and related subjects which were exhibited by the largest British Publishers.

The Ministry of Supply exhibited forty-one entirely new instruments evolved during the past year at Ministry of Supply research and development establishments. They included equipment which can count and measure alpha particles and gamma radiation; apparatus for measuring radium inside the human body; a portable tool for uranium prospectors; calculating machines which solve abstruse equations in a fraction of the time needed by a mathematician; a camera which breaks down the split-second processes of an explosion into fine detail and a micrometer which can measure the length to an accuracy of 0·0005 inches.

These instruments and apparatus have been developed and demonstrated at the Exhibition by scientists of the following establishments respectively:—Atomic Energy Research and Development Establishment; Chemical Defence Experimental Establishment; Radar Research and Development Establishment; Royal Aircraft Establishment; Signals Research and Development Establishment; Armament Research Establishment and Telecommunication Research Establishment.

Airmec Laboratories Ltd. has shown an H.F. Millivoltmeter for frequencies between 1 Mc/s. and 500 Mc/s.; their Miniature Oscilloscope designed for laboratory, workshop and educational use; the Airmec Colour Comparator; a General Purpose D.C. Oscilloscope; the Heterodyne Bridge Detector; an Electronic Counter incorporating six decades, allowing a count of 0 to 999,999 and a Radiation Monitor suitable for comparative and absolute measurements and for general tracer work.

Associated Electrical Industries have exhibited a Transmission Type Interferometer which can be incorporated in most standard type instruments; a Long Working Distance Microscope Objective System; Stereoscopic Electron Micrograms taken on a Metropolitan-Vickers type E.M.3 instrument and a Resistor Network for solving Partial Differential Equations.

The Automatic Coil Winder & Electrical Equipment Co., Ltd., displayed a number of interesting, newly developed instruments covering very wide fields of industry. The "AVO" Electronic Test Meter with its large number of ranges and comprehensive specification is of particular interest to all workers in the field of electronics, and refinements of the basic principles embodied into this instrument could be seen in the eighty range Electronic Test Meter Type "W" and the Precision Valve Voltmeter of particularly high accuracy.

Various accessories are available for use with the Electronic Test Meter, one of the most important being the Electronic Test Unit which is capable of producing readings which are normally quite outside the scope of all but the most highly equipped laboratories.

A unique Universal Bridge of good design and wide specification, and other High Sensitivity and specialised meters were available for inspection.

The British Thomson-Houston Co., Ltd., exhibited the following items of their Research Laboratory: (1) Optical Method for the Orientation of Silicon Iron Crystals; (2) Mass Spectrometer Leak Detector; (3) Magnetic Field Strength Meter; (4) The Use of Compact Source Electric Discharge Lamps for Combined General Illumination and Condenser Flash Work; (5) Radiation Sources for Laboratory Work; (6) Oscillatory Conditions produced by Electric Discharges in Mixtures of Mercury Vapour and Rare Gases under conditions of Cataphoresis; (7) Portable Direct-reading Electrometer Valve Meter suitable for Small Radiation Measurements; (8) BTH "Forrest" Miniature Insulation Test Set; (9) A Development in the use of Saturable Pulsactors as Discharge Devices for High Power Pulse Generators; (10) Electrical Plotter capable of generating two co-ordinate motions which together represent both the variable and the function; (11) Pulsed I.F. Signal Generator and (12) Waveguide Test Equipment.

A. E. Cawkell Electronic Engineers have shown a few of a number of specialized instruments completed to special order singly, or in small batches for particular requirements. They included an Industrial Noise Measuring Instrument; a Demonstration Amplifier for Schools; and a Slow Speed Oscilloscope with a long persistence tube for investigations at frequencies between ½ and 100 c/s.

Cinema-Television Ltd. have displayed and demonstrated a number of their most recently developed instruments. The exhibits included a Universal Valve Tester; R.C. Oscillator and Automatic Frequency Monitor; Self and Mutual Inductance Bridge, providing high accuracy in low inductance measurements; Wide Range Capacitance Bridge, for accurate low capacitance measurement; Stabilized High Voltage Power Pack; Microsecond Counter Chronometer, designed to meet the increasing demand for accurate measurement of short time intervals; Standard Electronic Counter, counting at a maximum rate of 30,000 per minute; Geiger-Müller Tubes for cosmic, gamma and beta ray counting, and Photoelectric and Multiplier Cells of the emission type.

Electro Methods Ltd. have shown and demonstrated their Magnetic Amplifiers and Low Inertia Motors. They have also exhibited Switching Reactors in Pulsing Circuits; Saturable Reactors, which are increasingly coming into use as low loss continuous power regula-

F.B.C.
TRADE MARK

BALL & ROLLER BEARINGS

Ball and parallel-roller bearings for every purpose.

The illustration shows F.B.C. ball and parallel-roller bearings on the pinion-shaft of a motor coach five-speed gear box.

FISCHER BEARINGS CO. LTD., WOLVERHAMPTON

Subsidiary of British Timken Ltd.

tors; Jet Temperature Control; Low Inertia Integrating Motors; Relays; Scientific Glassware; Miniature Pre-set Resistors and Low Voltage Lightning Arrestors.

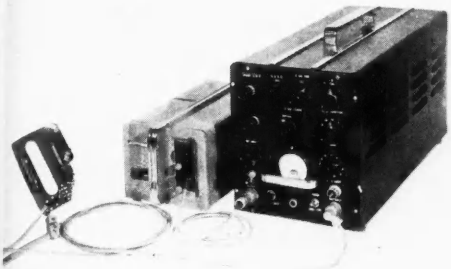
Electronic Instruments Ltd. have exhibited a new instrument, the Dynatherm, for indicating and measuring the surface temperatures of rapidly rotating or moving bodies, within the range of 200 to 1000 deg. C.; a Self Monitoring Electrometer; the Micovac Electronic Test Meter; a Twenty Million Megohmmeter and the Chronotron Millisecond Meter.

W. Edwards & Co., Ltd., have shown Rotary Vacuum Pumps; Diffusion Pumps; Water Jet Pumps with non-return Valve; Vacuum Gauges and Vacuum Plants.

Hall Telephone Accessories Ltd. have shown two entirely new Microhardness Testers, one for use with an Inverted Microscope, the other for use with a Bench Type Microscope. A special type of stage, of high accuracy suitable for microhardness testing has been shown with the instruments.

The display of **Kelvin & Hughes (Industrial) Ltd.** included their Single-Channel Strain Recorder.

Mechanical variables, such as strain, force, displacement, acceleration, fluid pressure, fluid flow, temperature etc., require to be translated into electrical quantities for recording, and for this purpose conversion elements of the generating or of the variable impedance type may be used.



Variable-impedance conversion elements can be used as modulators in conjunction with A.C. bridge circuits and carrier-type amplifiers in order to provide response at frequencies from zero upwards without introducing the disadvantages of direct-couple high-gain amplifiers. This method of use can be made to give high sensitivity and stability, excellent amplitude and phase characteristics, versatility of application and easy calibration by static methods.

An equipment using these principles has been designed for use with the Single-Channel Recorder. Contained in one unit are the bridge circuit 2 Kc/s oscillator, carrier amplifier, demodulator D.C. amplifier and power supplies. The Recorder forms a second unit. This equipment was demonstrated in its application to structural testing in aircraft.

The exhibit of **Metropolitan-Vickers Electrical Co., Ltd.,** included their "Metroflux" Simplified Permeameter for routine testing of magnet steels for remanence, coercivity, maximum energy and recoil data; an Electrostatic Clutch and their Continuously Evacuated Cathode-ray Oscillograph used for the observation and recording of the wave-shape and duration of the surges produced by an impulse generator. A General Purpose Mass Spectrometer for measurements on ions having m/e rations between 1 and 250 was demonstrated. Differential Methods of Vacuum Leak Detection have been demonstrated. Other instruments and apparatus on show included Waveguide Attenuators; Dilation-Temperature Recorder; a High-Speed Recurrent Waveform Monitor; Rotary Vacuum Pumps; Oil Diffusion Pumps and the Type EM4 Electron Microscope which has been developed as the topical complement to the types shown last year.

Mullard Electronic Products Ltd. exhibited new materials including a High Permittivity Ceramic K30 for high frequency by-pass condensers, several new grades of Ferroxcube core materials, and a large Adjustable "Ticonal" Permanent Magnet. New instruments shown included a Valve Impedance Test Gear for the accurate measurement of the input and output capacitance and damping resistance of thermionic valves under given operating conditions; a Moving Image Converter demonstrated as a quick-acting optical shutter; and an Ultrasonic Soldering Iron for the soldering of aluminium and its alloys; a Broad Band Oscilloscope for the observation and measurement of the waveforms of high-speed transients, and a F.M. Signal Generator, primarily intended for the servicing of F.M. receivers operating in the 90 Mc/s region. The testing of a halogen-filled Geiger Müller tube was also demonstrated, as well as a method for measuring the noise factor of travelling-wave tubes at 10 kMc/s.

Philips Electrical Ltd. exhibited and demonstrated the new Philips X-ray Diffraction Unit which offers wide scope for non-destructive chemical analyses, and the identification of the alloy components and compounds of metals.

Sangamo Weston Ltd. have shown barrier layer selenium rectifier type photo-electric cells. They are available with outputs ranging from 80 to 140 microamperes at 40 foot candles and 1,600 ohm external resistance, and for most purposes require no external current supply to operate D.C. instruments or relays.

A Multi-Range Test Set has also been shown. This has 53 ranges for measuring A.C. and D.C. current and voltage, resistance and insulation. It is completely self-contained and require no external accessories or power supply.

Two types of the Weston Standard Cell have been displayed: the normal or saturated cell, 1.01824 volts at 20 C and the standard or unsaturated cell e.m.f. 1.0186 volts at 20 C.

Standard Telephones and Cables Ltd. have exhibited a new type E.H.T. Tubular Rectifier incorporating high voltage discs for the first time; a new type Miniature Selenium Metal Detector; a new type of high-frequency attenuator employing push-button switches; a new V.H.F. Signal Generator; Crystals; Cable Testing Equipment and a range of "Stantel" Thermistors for industrial and research applications.

Displays of technical and scientific books formed an important section of the Exhibition. Thousands of scientists, professional and industrial workers and students have been able to examine many of the most recent scientific and technical volumes. This section included the exhibits of the following Publishers:—

Blackie and Son Ltd.

Blakey: University Mathematics. *Champion:* University Physics, Part I-V. *Grimsehl:* A Textbook of Physics. *Nelkon:* Heat. *Wood:* Acoustics. *Champion:* Properties of Matter. *Roberts:* Heat and Thermodynamics. *Abraham:* The Classical Theory of Electricity and Magnetism. *Wilson:* Modern Physics. *Vigoureux and Webb:* Principles of Electric and Magnetic Measurements.

Quality IS THE KEYNOTE . . .
Poetry of movement, eloquently and gracefully expressing every human emotion. Only that at its highest degree of perfection wins the title of ballerina. The same energy of mind and devotion to an ideal is equally essential in our particular sphere, This enables us to maintain the highest degree of Quality. Castings by Edward Matthews Ltd. measure up to the most exacting standard — always. That is why we can offer our products with such confidence. We know that they will meet with the fullest approval of the most meticulous engineer.
SPECIALISTS IN SOFT GREY
IRON CASTINGS FOR ALL TRADES
Edward Matthews Ltd.
IRONFOUNDERS, BILSTON, STAFFORDSHIRE.
TELEPHONE: 41461, 41462, BILSTON
TELEGRAMS: "CASTINGS BILSTON"

Chapman & Hall Ltd.

Durrans : Solvents. *Harvey :* H.F. Thermionic Tubes. *Tibbs :* Frequency Modulation Engineering. *Sturley :* Radio Receiver Design, 2 vols. *Judge :* Engineering Precision Measurements. *Lewis :* Radio Servicing Equipment. *Judge :* Stereoscopic Photography. *Scowen :* An Introduction to the Theory and Design of Electric Wave Filters. *Penn :* High Polymeric Chemistry. *Ower :* Measurement of Air Flow. *Peacock :* A Symposium of Electronics. *Zepler :* Technique of Radio Design. *May :* Industrial H.F. Electric Power. *Alar :* Modern Methods for the Analysis of Aluminium Alloys. *Sandeman :* Radio Engineering, 2 vols. *Caldin :* Power and Limits of Science. *Rolfe :* A Dictionary of Metallography. *Cherry :* Pulses and Transients in Communication Circuits. *Page :* Fine Surface Finish. *Gaydon :* Spectroscopy and Combustion Theory. *Gaydon :* Dissociation Energies. *Greenless :* Amplification and Distribution of Sound. *Amos and Kellaway :* Radio Receivers and Transmitters. *McNicol :* Radio Conquest of Space. *Bourne :* Discharge Lamps for Photography and Projection. *Semat :* Introduction to Atomic Physics. *Yarwood :* High Vacuum Technique. *Nimmo :* Atomic Energy. *Janossy :* Cosmic Rays and Nuclear Physics. *Friedlander* and Kennedy : Introduction to Radiochemistry. *Harry Boyer Weiser :* Colloid Chemistry. *Sanderson :* Vacuum Manipulation of Valatile. *Rice and Teller :* The Structure of Matter. *Daniels :* Outlines of Physical Chemistry. *Wheland :* Advanced Organic Chemistry. *Wheland:* Isotopic Carbon. *Remick :* Electronic Interpretations of Organic Chemistry. *Yagoda :* Radioactive Measurements with Nuclear Emulsions. *Attwood :* Electric and Magnetic Fields. *Pollard and Davidson :* Applied Nuclear Physics. *Darrow :* Atomic Energy. *Green :* Industrial Rheology and Rheological Structures. *Kimbark :* Electrical Transmission of Power and Signals. *Zworykin and Ramberg :* Photoelectricity and its Application. *Pollard and Sturtevant :* Microwaves and Radar Electronics. *Wiener :* Stationary Times Series. *Ware and Reed :* Communication Circuits. *Skilling :* Fundamentals of Electric Waves.

MacMillan & Co., Ltd.

Milne-Thomson : Theoretical Hydrodynamics. *Milne-Thomson :* Theoretical Aerodynamics. *Ferri :* Elements of Aerodynamics of Supersonic Flows. *Allen and Moore :* A Textbook of Practical Physics. *Yarwood :* Intermediate Practical Physics. *Noakes :* A Textbook of General Physics. *Strutt :* Ultra and Extreme Short Wave Reception. *Barton Hoag and Korff :* Electron and Nuclear Physics. *Inanananda :* High Vacua. *Olson :* Elements of Acoustical Engineering. *Schwarzkopf :* Powder Metallurgy, its Physics and Production. *Schelkunoff :* Applied Mathematics for Engineers and Scientists.

Sir Isaac Pitman & Sons Ltd.

Keen : The Principles of Television Reception. *Williams :* Antenna Theory and Design. *Langton :* Radio Frequency Heating Equipment. *Cotton :* Electrical Technology. *Ferns :* Meter Engineering. *Lewitt:* Hydraulics. *Constable :* Principles and Practice of Sound Insulation. *Rao :* Calculation, Design and Testing of Reinforced Concrete. *Lewitt :* Thermodynamics Applied to Heat Engines. *Powell :* Elementary Physics for Technical Students. *Martin :* Technical Optics.

CHANGE WHEEL GEARING

Continued from page 122

4550 revolutions, or during $\frac{9775}{3} = 3258\frac{20}{60}$ revolutions of the gear 60, the driving shaft makes $4550/3 = 1516\frac{2}{3}$ revolutions.

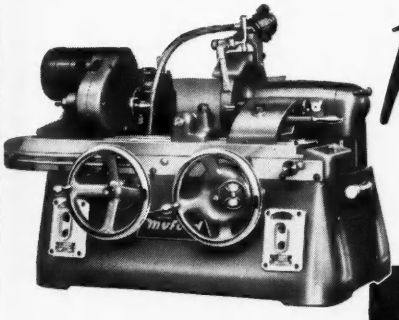
Example 23 has only a theoretical significance, as turning a gear several thousand times is impracticable. An attempt to simplify indexing by using the gear 60 (in Example 23) as first or second driver would lead to interference.

Although six-gear trains permit indexing in most cases, they are no guarantee. If, for example, a two-start thread is required with the ratio $\frac{115\times 95}{65\times 85}$, indexing cannot be performed even if two gears 20 are available. The gear train $\frac{115\times 95\times 20}{20\times 65\times 85}$ is unsuitable, as the quotient of the driving and driven gears used, reduced to its lowest terms, is not divisible by 2; an attempt to change the order of the gears would be of no use because of interference.

Indexing, however, is possible if there are, for example, two gears 90; both gear trains $\frac{115\times 95\times 90}{65\times 85\times 90}$ and $\frac{90\times 115\times 95}{65\times 85\times 90}$ can be mounted. The former gear train uses the recommended order of gears, but indexing is impracticable, similarly as in Example 23; the latter gear train renders indexing very simple, without any interference (the risk is interference between the gear 115 and the lock nut on the driving shaft).

From this point of view, it is expedient to have a larger gear than 20 in duplicate; the gear 60, for instance, would be suitable in many cases. It is of medium size, and is divisible by all numbers from 2 to 6.

(*To be continued.*)



Myford "MG9" PRECISION CYLINDRICAL GRINDER

Work Swing—5 in. diameter
Between Centres—9 in.
Dial Reading—.0001 in.
Fine Wheel Feed—.00005 in.
This machine is also available on Steel Cabinet Stand

SOLE MANUFACTURERS
MYFORD ENGINEERING COMPANY LIMITED
BEESTON · NOTTINGHAM · ENGLAND

LATEST INDUSTRIAL LITERATURE

1. Single Piece Core Hydraulically Die Cast Pistons for Diesel Engines. This excellent 20-page brochure, 20-in. by 10½-in., deserves space in the library of every progressive technician interested in automotive engineering. Apart from concisely dealing with the design features and the material utilised for the manufacture of the single piece core pistons, the brochure contains well reproduced blueprints of such pistons which are used in many Diesel engines of world repute.

2. Kathanode Traction Batteries. 40-page booklet, neatly illustrated, shows all leading makes of trucks and delivery vehicles. Eight pages are devoted to the development of electric traction and Kathanode batteries in particular, following which there are four pages of curves to provide useful technical data to all users of battery operated vehicles.

3. Wimet Standard Tools Manual. The more important manufacturers of Tungsten Carbide tipped tools have recently introduced a new range of standard lathe and planer tools. The large number of styles has been reduced without affecting the field of application of such tools. This 124-page Manual, edited, designed and produced with expert care and excellent taste, shows the new range, and an Equivalents Booklet compares the new tools with the tools which they supplant.

4. Electro-chemical Rust Removal. Illustrated 12-page brochure giving particulars of an electro-chemical process for removing rust, corrosion and other extraneous surface deposits from metal. Complete machines and assemblies can often be de-rusted with this process (which does not attack sound metal) without any dismantling.

5. Railway Fastenings; Transmission Line Equipment; Fabricated Steelwork; General Forgings. 160-page catalogue, illustrated with diagrams and photographs. Section 1 is devoted to Permanent Way Fastenings; Nuts and Bolts; Agricultural Ironwork; Forgings and Bar work. Section 2 deals with Electrical Overhead Transmission Line Equipment for High Tension, Telegraph and Telephone Lines. Section 3 offers an illustrated description of the works and the manufacturing equipment available.

6. Electronic Equipment for Industry. 16-page booklet describing a range of electronic equipment which have already proved their value in service to industry.

7. A Survey of Material Handling. 38-page illustrated booklet the purpose of which is to describe in simple terms what material handling means; to show the various types of material handling equipment available and to indicate the economic advantages of improved material handling.

8. 12 in. Semi-Automatic Hydraulic Profiling Lathe. Illustrated 16-page brochure describing a Semi-Automatic Profiling Lathe for Profile Turning. The machine is hydraulically controlled throughout and is designed for the batch production of components by semi-skilled operators. The profile of the components is obtained automatically by using a completed component or template as a master. Profiles within the capacity of the cutting tool can be reproduced accurately.

9. An Extreme Pressure Soluble Cutting Oil. Machining of nickel chrome alloys and heat resisting austenitic alloy steels require a copious flow of cutting fluid of extreme pressure properties. The leaflet offered gives comparative results from drilling tests which were made with soluble oils and a new cutting oil of extreme pressure properties which has been developed after many years of research.

10. Renewable Seat Sleeve Valves. Illustrated leaflet describing salient features of a renewable seat sleeve valve suitable for steam, water, fluids and air, and showing the advantages of this patented device.

11. Power for Industry. The urgent necessity for installing private generating plant to meet the restrictions imposed on grid electric supply has resulted in the development and availability of the four standardised diesel-driven alternator sets, ranging from 60 to 330 kVA capacity, which are described in great detail in this brochure. Running costs of such plants are estimated at ¾d. to 1¼d. per unit. Specifications and photographs of some power units and of actual installations are included.

12. Electrical Alloy Data Book. 60-page booklet with a wealth of information, data and specifications pertaining to alloys for electrical resistance. Numerous charts and tables facilitate the establishment of a working basis for the application of the alloys, which include high temperature heating, spark plug electrodes, motor starters, thermo-couples, glass-to-metal seals, radio valve manufacture, wire weaving, rheostats, etc. Thumb-indexing and the practical use of different colour for each section ensure that information required can be quickly found.

13. "Ethulon" Tracing Film. Leaflet introducing a new plastic tracing medium for general drawing office and photo reproductive work. Fine continuous lines, high ink adhesion, easy erasure, high dimensional stability, long life, ease of handling, excellent translucence and accurate colour separation are claimed as salient features of this new tracing film.

14. Free Machining Wrought Alloys. Leaflet giving specifications of various grades of wrought zinc-free bronze alloys the machineability of which has been greatly improved as a result of many years of research. The essential features of wrought bronze of equal tin content, tensile strength, ductility, bearing and corrosion resistance properties have been retained or improved, whilst thermal and electrical conductivity has remained unimpaired. General machining properties have increased threefold.

15. Springs. Illustrated 24-page catalogue just issued to introduce a new stock range of helical compression and extension springs. Specifications of high duty die springs are included. Dimensional and load characteristics are given.

16. Electron Diffraction Camera. Technical Bulletin describing a new Electron Diffraction Camera which is becoming increasingly appreciated as a powerful research tool for the investigation of surface phenomena, e.g., the structure of thin films, surface layers of materials, metallic oxides and compounds, corrosion, plating, lubrication, metal-to-rubber bonding, etc. The bulletin in which the outstanding features of the camera are fully outlined and illustrated should be of great interest to Physicists, Chemists and Metallurgists.

17. "V" Link Belting. Profoundly illustrated 32-page booklet describing the design features, manufacture and advantages of "V" Link Belting. Simplified tables, including simplified horse power rating tables for designing drives are included. The booklet is of much interest to transmission engineers and others concerned with the design, installation and application of transmission drives.

18. Resilient Gear Wheel. Illustrated 6-page folder just published to describe a resilient gear for traction purposes which is of robust design and contains a minimum of wearing parts. The folder also contains detailed specification and illustrations of a typical design for a railway gear wheel.

19. Coolant Fittings. Swivels and Taps for Machine Tools. 8-page brochure containing specifications and illustrations of a standard range of coolant fittings used for accurately and efficiently distributing machine coolant and cutting oils on machine tools.

20. Pneumatic Equipment. Leaflet just issued contains excellent illustrations and brief description of a new range of pneumatic equipment, such as pneumatic hoists, a pneumatic vice for milling and drilling operations, an ejector valve for ejecting workpieces from hand presses after completion of operation, air line valves and puffer valves.

21. New Method of Corrosion-Preventive Packaging. 16-page brochure dealing with a new method of preventing corrosion even when moisture and oxygen are present. The stable organic compound described may be applied in four distinct ways: as a powder; as a solution; as a coating on wrapping material, or embodied in a "cocoon" webbing solution. This development should be of much interest in protecting scientific instruments, motor parts and accessories, tools, bearings, nuts and bolts, machinery, wire, moulds and dies, etc.

22. Improved Vickers Patent Machine Reamer. Illustrated 12-page booklet just issued describes the salient features of the Improved Vickers Patent Machine Reamer with micrometer adjustment. Construction details are also described and fully illustrated. Adjustment is very simple in spite of the positive lock, and any diameter can be obtained within the capacity of the reamer in less than one minute.

23. Universal Locator Base and Attachments. Illustrated leaflet describing an universal locator base especially designed for instantly locating the work-piece at a convenient angle. Ideally suitable for the tool-room, machine shop and inspection bench.

24. Brinell Microscopes. Leaflet just published illustrates and describes electric and daylight patterns of a Brinell Microscope which has been designed to provide an easy and accurate method of measuring the ball impression made by a Brinell Hardness Tester. These microscopes are quite versatile and useful also for measuring line thicknesses, datum marks and radii, etc.

MAIL THIS COUPON TODAY

THE ENGINEERS' DIGEST, IV-50
120, Wigmore Street, London, W.1.

Date.....

Please send free and without obligation the literature indicated by the following circled numbers:

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24

Name .....

Position .....

Company.....

Address .....

NEWS OF THE MONTH

PERSONAL

Mr. W. Balfour has been appointed engineer-in-charge of the studio centre and transmitting station of the British Broadcasting Corporation at Aberdeen.

Lieut.-Colonel T. Child, M.I.Mech.E., has been appointed general manager of the British Engineers' Small Tools and Equipment Co., Ltd., 6 Buckingham Street, London, W.C.2.

Mr. J. Crawford has been appointed by the Lord President of the Council as a Member of the Advisory Council for Scientific and Industrial Research.

Mr. John T. Davenport has been appointed director and general manager, and **Mr. Ralph Carr** director and secretary of the Alston Foundry Co., Ltd., Alston, Cumberland, a subsidiary company of Steels of Sunderland.

Mr. A. A. H. Douglas, A.M.I.Mech.E., has been appointed director and general manager of the Distington Engineering Co., Ltd., Workington, Cumberland, a subsidiary company of The United Steel Companies Ltd.

Mr. J. Eccles, chairman of the Merseyside and North Wales Electricity Board, has been elected President of the Liverpool Engineering Society.

Mr. A. L. Fielding, M.I.C.E., M.I.E.E., A.M.I.Mech.E., advisory and inspecting engineer for the New South Wales Government, has been appointed, in addition, official representative for the Snowy Mountains Hydro-Electric Authority of the Australian Government, c/o New South Wales Government Offices, 56-57 Strand, London, W.C.2.

Mr. W. O. Gascoigne has been appointed resident engineer in the Midland area for Renfrew Foundries Ltd., Hillington, Glasgow, S.W.2.

Brigadier A. W. Griffin, director of Jack Olding & Co., Ltd., and **Mr. W. A. Buell,** export manager of the Barber-Greene Co., Aurora, Illinois, have been elected to the Board of Barber-Greene Olding & Co., Ltd., Hatfield, Hertfordshire. **Mr. E. L. Harber** has been appointed managing director, and **Mr. F. G. Flockhart,** production engineer of the Company.

Mr. J. H. Groocock has been appointed chief electrical engineer of the Abbey, Margam and Port Talbot works of the Steel Company of Wales Ltd.

Professor G. de Hevesy has been presented with the Faraday Medal by the Chemical Society.

Mr. L. B. Hewitt, A.M.I.E.E., has been appointed stores standardisation officer in the Department of Chief Technical Planning and Supplies Officer of the London Transport Executive.

Dr. E. H. T. Hoblyn, F.R.I.C., has been appointed director of the British Chemical Plant Manufacturers' Association and the British Food Machinery Manufacturers' Association, 14 Suffolk Street, London, S.W.1.

Mr. D. R. Johnson has been appointed Vice-President of Associated British Oil Engines Inc., New York, the new American sales company set up by ABOE last year.

Mr. C. C. Massey has been appointed sales manager, sheet department, of the Steel Company of Wales Ltd. **Mr. A. J. Jenkins** will continue as sales manager of heavy steel and other products. **Mr. J. Powell, A.M.I.Mech.E.,** has been appointed engineer-in-charge of the Abbey Works of the Steel Company of Wales Ltd.

Mr. W. H. McFadzean, deputy chairman of British Insulated Callender's Cables Ltd., 103 Mount Street, London, W.1, has been appointed chief executive of the company and will hold both offices. **Mr. L. G. Brazier, Ph.D., B.Sc., M.I.E.E., A.F.R.Ae.S.,** director of research, and **Mr. H. J. Stone, M.C., M.I.E.E.,** have been elected directors of the Company.

Mr. F. A. A. Menzies, C.B.E., B.Sc., M.Inst.T., chief development and research officer to the London Transport Executive, has been elected President of the Institute of Actuaries.

Mr. H. J. Nichols, C.I.E., D.Sc., M.I.C.E., A.M.I.Mech.E., has been appointed Registrar and Secretary of the Professional Engineers Appointment Bureau, 9 Victoria Street, London, S.W.1.

Mr. Frank Parr has joined the Whitehead Iron and Steel Co., Ltd., as a special director.

Dr. A. G. Quarrell, research manager of the British Non-Ferrous Metals Research Association, has been appointed head of the new post-graduate school of physical metallurgy at Sheffield University.

Mr. R. M. Robson, B.Sc., has been appointed chief engineer of the D.P. Battery Co., Ltd., Bakewell, Derbyshire.

Mr. R. A. Riddles has been elected President and **Mr. J. F. B. Vidal,** a Vice-President of the Institution of Locomotive Engineers.

Mr. J. F. Ronca, O.B.E., A.R.C.S., A.R.I.C., A.M.I.Mech.E., Hon.M.Inst.Gas E., F.Inst.F., who is taking up office as President of The Institute of Fuel in October, 1950, has joined the Board of Directors of George Wilson Gas Meters Ltd.

Mr. J. J. Rutter has been appointed manager of the electrical department of the Sunderland Forge & Engineering Co., Ltd., Pallion, Sunderland.

Major-General W. S. Tope, C.B., C B.E., M.I.Mech.E., M.I.E.E., has been appointed a director of Henry Meadows Ltd., Wolverhampton, and has been elected chairman of the Company.

Mr. C. E. H. Verity, O.B.E., M.I.C.E., M.I.Mech.E., M.I.E.E., has been appointed deputy chief engineer (generating station construction) to the British Electricity Authority.

OBITUARY

Dr. Alexander Klemin, educator and authority on helicopters, great engineer and a man of exceptional charm and human qualities, died at his home at Anderson Road, Greenwich, Connecticut, at the age of 61.

Only two month's ago, the New York University conferred upon him an honorary degree of engineering for his contributions to aeronautical education. Dr. Klemin was head of the Guggenheim School of Aeronautics at New York University from its founding until he retired in 1941. At the time of his death he was technical editor of "Aero Digest" and Chairman of the American Editorial Advisory Board of "The Engineers' Digest."

A native of London, Dr. Klemin received the B.Sc. degree from London University in 1907. In 1914 he went to the U.S.A. where he received a year later the M.Sc. degree from Massachusetts Institute of Technology.

In 1921 he perfected the first amphibian landing gear used in the U.S.A., and won several Army and Navy design competitions. Upon his retirement in 1941, the post of Guggenheim research professor of aeronautics was created for him at the N.Y.U.

A member of the American Society of Mechanical Engineers, the Society of Automotive Engineers, the Royal Aeronautical Society, the Institute of Aeronautical Sciences and Engineers and Wings, Dr. Klemin was the author of "Textbook of Aeronautical Engineering," "If you want to Fly," "Simplified Aerodynamics" and "Airplane Stress Analysis." He was also consulting technical editor to the Pitman Publishing Corporation.

YOUR PROBLEM is our business!

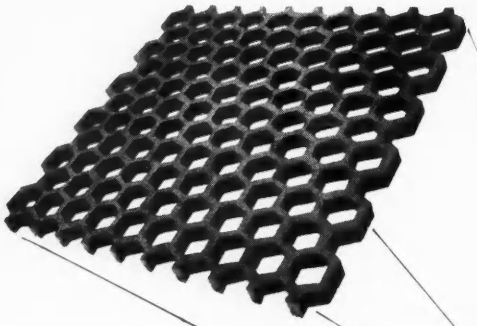
* RECLAIMING MACHINE SHOP ERRORS AND WEAR.
* HARDENING WITHOUT DISTORTION.

Specify— BRAILEY (Regd.)

FOR HARD CHROMIUM AND HEAVY NICKEL ELECTRO-DEPOSITION.

* Our 32-page booklet covers many applications of the process and will be sent on written request to responsible enquirers. Our technical representative will be pleased to call.

BRAILEY Electroplaters Ltd
ESTABLISHED — 1872
CHAPEL ST · SALFORD · LANCS.
RB B49



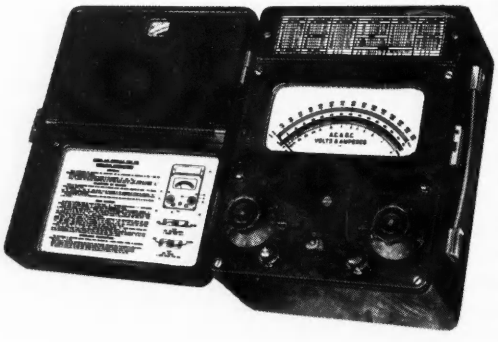
See our exhibit at the Building Centre
9 Conduit Street, London W.1

For PERMANENT
Concrete floors use
GKN Patent Cast-Iron
Honeycomb Floor Plates

Easy to lay, prevent surface disintegration, and make a cast-iron surface of reinforced concrete over which the heaviest industrial traffic will roll for years and years.

GUEST KEEN & NETTLEFOLDS (CWMBRAN) LTD. *CWMBRAN WORKS, CWMBRAN, MON.*

GKN
CWMBRAN
C/HONEYCOMB 4201



53 Ranges with Rotary Switch Selection

This uniquely comprehensive Test Set has 53 ranges for measuring AC and DC current and voltage, resistance and insulation. It is completely self-contained, with internal batteries to provide power for the ohms ranges and self-contained power pack for insulation measurement at 500 v. Selection is carried out by two 20-position switches. A fully protective safety device is fitted and is operative for forward or reverse overload. The 150 division 6 in. scale is uniformly divided and is fitted with an anti-parallax mirror. The set is enclosed in a handsome bakelite case and fully complies with B.S.S. No. 89 covering first grade instruments. Full details of this, and other Weston electrical measuring instruments will gladly be supplied on request.

The WESTON S.75 Multi-Range Test Set

SANGAMO WESTON LIMITED,
ENFIELD, MIDDLESEX.

TELEPHONE: ENFIELD 3434 (6 LINES) and 1242 (4 LINES)
TELEGRAMS: SANWEST, ENFIELD.

Area Depots:
201 St. Vincent Street, Glasgow. *Central* 6208.
Milburn House, Newcastle-on-Tyne. *Newcastle* 26867.
22, Booth Street, Manchester. *Central* 7904.
33, Princess Street, Wolverhampton. *Wolverhampton* 21912.

B.I.F., May 8th—19th. Birmingham Stand No. C 505. London Stand No. C 77.

BUSINESS NOTES

The Institution of Gas Engineers has changed its address to 17 Grosvenor Crescent, London, S.W.1. (Tel. SLOane 8266).

The Selson Machine Tool Co., Ltd., has moved its head office and showrooms to Cunard Works, Chase Road, London, N.W.10. (Tel. ELGar 4000).

R. W. Gregory & Partners, consulting engineers, Newcastle-upon-Tyne, have opened an office at 18 Baldwin Street, Bristol 1 (Tel. 23316). **Mr. L. L. C. Rettig, F.I.E.S., A.I.E.E.,** who has joined the firm as a partner will be in charge of the Bristol office.

Mr. R. W. Griffin, B.Sc.(Eng.), A.M.I.E.E., and **Mr. Cecil H. Smith, B.Sc.(Eng.), A.C.G.I.,** have started practice as consulting engineers under the name of **Griffin, Smith and Partners, Ltd.,** at 28 St. James's Place, London, S.W.1. (Tel. REGent 7191). They are specializing in instrumentation and industrial process control.

F. C. Robinson & Partners Ltd., consultants on industrial electronic applications, 287 Deansgate, Manchester 3, announce that they are sole agents for Mullard Electronic products in the North of England. This agency relates, however, to Mullard's Electronic Equipment Division only and does not embrace valves, cathode ray tubes and communication equipment.

Specialloid Ltd., North Finchley, N.12, announce that their new Leeds factory is now in production. The Sales and Technical departments are also operating from Leeds. The address is Specialloid Ltd., Black Bull Street, Leeds 10. (Tel.: 31471/7).

John S. Young & Co., Ltd., 257-261 Eglinton Street, Glasgow, C.5, have been appointed joint distributors for the complete range of "Ernst" portable direct reading hardness testers for Great Britain and Ireland.

Quasi-Arc Co., Ltd., Bilston, Staffordshire, will be handling as from April 1st, all sales and service for "Unionmelt" automatic arc-welding equipment.

Acheson Colloids Ltd. have removed their offices to 18-19 Pall Mall, London, S.W.1. (Tel.: WHItehall 2034-7).

Brush (Far East) Limited has been formed with registered offices in Ocean Buildings, Singapore, to be factory representatives of Petter, Petter-Fielding, McLaren, Mirrlees, National and Meadows diesel engines and of the products of Bryce Fuel Injection Ltd. and The Brush Electrical Engineering Company, Ltd., in Malaya, Indonesia, French Indo-China, Borneo, Sarawak, Siam, Philippines, China, Hong Kong, Japan, Formosa and Ceylon.

Mr. H. F. Clements is Chairman and the Hon. A. C. Geddes, Mr. F. A. Vaughan, Mr. A. A. King are directors. The individual companies will, however, continue to sell their products through their existing agents.

Clarkson (Engineers) Limited, makers of the well-known Autolock Chucks and a wide range of Milling Cutters, have now opened London Offices and Showrooms at 110 Hammersmith Road, London, W.6. (Tel.: RIVerside 6645).

The large stock carried includes Autolock Chucks, End Mills, Keyseating and Woodruff Cutters, Teeslot Cutters, Paper-fluted Die-sinking Cutters, Side and Face Cutters, Angle Cutters, Shell End Mills, Arbors, Counterbores and Counter-sinking Cutters.

Simmonds Aerocessories Ltd., Treforest, Glamorgan, are rapidly expanding sales representation both at home and overseas for their Self-Locking Nuts (including a new Nyloc version), Fram Oil Cleaners, Spire Speed Nuts and Liquid Contents Gauges. Production has been increased under the direction of Mr. L. G. Oxford, who has been appointed Joint Managing Director, and Mr. C. J. Turner, Works Manager. Mr. E. S. Mead has become General Sales Manager of the five sales divisions.

Mr. Oxford has recently returned from America, where he visited several large plants, including the Fram Corporation, Providence, and Tinnerman Products Inc., Cleveland, in order to study the latest technical and production methods.

Mr. C. Rosier, General Manager, Simmonds Aerocessories Pty., Ltd., Melbourne, recently visited this country to formulate plans to meet the growing requirements of this important market. Spire Speed Nuts are now being manufactured in Australia and as from May 1st, 1950, this Company will handle all sales of Fram Oil Cleaners. Arrangements are being made for the eventual manufacture and assembly of Fram in Australia.

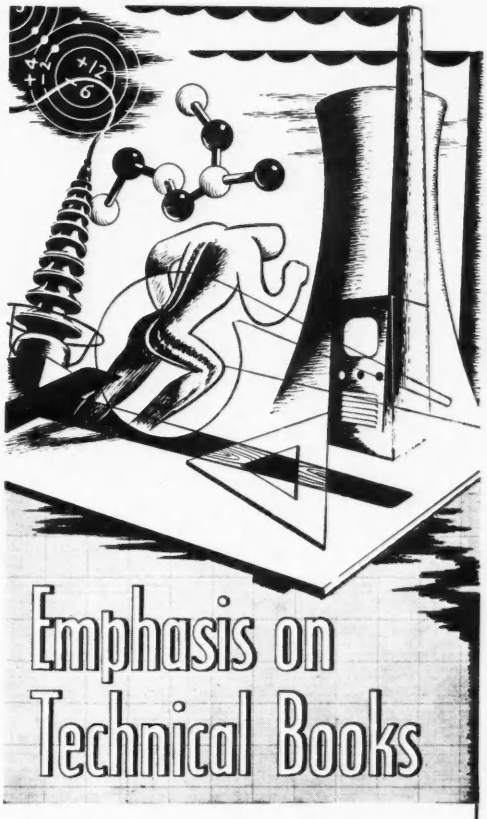
Increased trade in the Scandinavian countries has necessitated the opening of a branch sales office in Stockholm under the direction of their Swedish Manager, Mr. Curt Edgren.

Mr. C. W. Hayward, Chairman of Simmonds, has left for Durban to study trade conditions and to arrange for extended sales representation throughout the Union.

MARFORM PROCESS

A new efficient and economic process of precision metal forming known as the "Marform Process" has been developed by The Glenn L. Martin Co., U.S.A.

By arrangement with Glenn Martin, The Loewy Engineering Co., Ltd., Manfield House, 376 Strand, London, W.C.2, will undertake the introduction of the Marform Process in the United Kingdom the British Commonwealth, Europe, and other territories. Complete presses as well as equipment for incorporation into existing presses to carry out the Marform Process will be supplied by Loewy Engineering who intend to build the equipment in their works at Light Machines Ltd., Yeovil. Technical information and assistance is available for potential and actual users of the process.



Executives,
technical training officers,
and works librarians

who are constantly seeking the newest technical publications will find a quick and competent service at any branch of W. H. Smith & Son. Bookstalls can supply your requirements just as easily as the W.H.S. shops. Each is in daily contact with Head Office in London and your orders, either for single copies or complete works libraries, will be fulfilled within the shortest possible time.

W. H. SMITH & SON

for service

BRANCHES THROUGHOUT THE COUNTRY

AIR FRANCE

The first

Airline in the World

AIR FRANCE · 52 HAYMARKET · LONDON · S.W.1

TELEPHONE: WHITEHALL 0971

BIRMINGHAM · MANCHESTER · GLASGOW · BELFAST

ICI

METALS DIVISION

are exhibiting

COPPER AND ALUMINIUM

and their alloys in

strip, sheet, plates. tubes, rods, sections, extrusions, wire and sundries

BIRMINGHAM MAY 8-19

STAND NO B.I.F 1958 **D409-308**

IMPERIAL CHEMICAL INDUSTRIES LIMITED LONDON SWI

M.176

Reed Vibrometer Amplitude Scale. The General Electric Company, Ltd., has produced an amplitude scale for use with its well-known Reed Vibrometer. Many users of this instrument on power station plants, machine tools, transport vehicles, ships, aircraft, etc., have expressed a wish for a simple scale to enable relative amplitudes to be measured and the instrument is now supplied with such a scale at the same price (£5. 18s. 6d.). Users who purchased the instrument before the scales were supplied will be sent one free of charge on application to M. Dept., The General Electric Co., Ltd., Kingsway, London, W.C.2, quoting the serial number of the Vibrometer in their possession.

Prolite Solid Tungsten Carbide Twist Drills. The lower range of sizes of drills do not lend themselves to be tipped with carbide, but solid carbide drills are now available, and in the hands of skilled mechanics or on automatic machines they can be used effectively and with advantage notwithstanding their brittle nature.

The most suitable size range for Tool Room work is from $\frac{1}{8}$ in. to $\frac{1}{2}$ in., and for metal powders and plastics ·052 in. to $\frac{1}{16}$ in.

Solid drills of this description are used in the work of Prolite Ltd., for drilling high speed steel parts of approximately $\frac{1}{16}$ in. thickness, and heat treated carbon, nickel chrome or other hardened steel sections up to approximately $\frac{1}{4}$ in. thickness.

Parts of intricate shape where holes might lead to breakage or distortion can in many cases be hardened and subsequently drilled to suit the required assembly.

Conference on Isotopes in Industry. The Department of Extra Mural Studies of the University of Birmingham, in conjunction with the Birmingham Branch of the Atomic Scientists' Association, is holding a Conference on "Isotopes in Industry" from May 19th to May 21st next, at the University, Birmingham.

The Conference is designed to introduce radioactive isotopes and the associated techniques to industrial scientists and technologists. Further details may be obtained from the Department of Extra Mural Studies, University of Birmingham, Edmund Street, Birmingham, 3. (Tel.: Central 8541, Extension 12).

Sir William J. Larke Medal. The Council of the Institute of Welding have awarded the Sir William J. Larke Medal, for the best paper read to the Institute during the year, to Mr. R. G. Braithwaite, M.I.C.E., M.Inst.W. Mr. Braithwaite is welding Consultant to Braithwaite and Co. (Structural) Ltd., and was last year Chairman of the Birmingham Branch of the Institute. His paper deals with the control of distortion in arc welding.

BOOKS

Application of the Electronic Valve in Radio Receivers and Amplifiers. By Dr. B. G. Dammers, Ing. J. Haantjes, J. Otte and Ir. H. van Suchtelen. Publishers: N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands. Sole Distributors for Great Britain and Eire: Cleaver Hume Press Ltd., 42a South Audley Street, London, W.1. 416 pp. 256 illustrations. PRICE: 35/-.

T. E. Goldup, M.I.E.E., technical director of The Mullard Radio Valve Co., Ltd., welcomes this book as most timely, for it fills a gap in current technical literature on the subject of thermionic valve applications and meets a long-felt need. It is thought the book will appeal specially to designers and engineering students as judicious selection and preparation of the material has resulted in a carefully condensed standard work of reference containing all necessary engineering information ably supplemented with mathematical explanations.

Metallic Creep. By A. H. Sully, M.Sc., Ph.D. Publishers: Butterworths Scientific Publications, Bell Yard, Temple Bar, London, W.C.2. 278 pp. 138 illustrations. PRICE: 25/-.

Dr. Sully was member of the research team which evolved during the war some of the most interesting creep resistant alloys. They have been applied to the construction of aircraft engines, but other applications have been successfully tried, and much experimental work is going on with the development of such alloys and their applications. The book is of great value to metallurgists and to designers interested in alloys capable of bearing high stresses at very high temperatures.

Modern Works Management. By G. Samuel Mason, B.Sc., M.I.Chem.E., F.C.I.S., F.I.I.A. Publishers: Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. 209 pp. PRICE: 15/-.

This book discusses in clear and logical language the problems of scientific works management. It also deals in detail with such important aspects of the subject as Raw Material Control, Labour Control, Control of Workmanship, Cost Control and Administrative Control.

The Calculation of Sheet Metal Work. By A. Dickason. Publishers: Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. 250 pp. 142 figures. PRICE: 15/-.

This book covers all the various types of calculation problems met with in sheet metal work.

Analysis and Lubrication of Bearings. By Milton C. Shaw and E. Fred Macks. Publishers: McGraw-Hill Book Company, New York, Toronto and London. 618 pp. PRICE: 85/-.

This book is of exceptional value on the fundamental problems underlying the design and performance of shaft bearings.

Sight Light and Efficiency. By H. C. Weston. Publishers: H. K. Lewis & Co., Ltd., 136 Gower Street, London, W.C.1 308 pp. 132 illustrations (including 13 coloured plates). PRICE: 42/-.

Gas Turbines and Jet Propulsion. By G. Geoffrey Smith, M.B.E. Publishers: Iliffe & Sons, Ltd., Stamford Street, London, S.E.1. 386 pp. PRICE: 21/-.

The International Mercantile Diary and Year Book. Publishers: The Syren and Shipping Ltd., 26-28 Billiter Street, London, E.C.3. 316 pp. PRICE: 30/-.

This Yearbook should be of greatest benefit to exporters who will find in it a wealth of information which is of utmost importance in facilitating the technicalities of the export business.

CHAPMAN & HALL

Recently published

ENGINEERING PRECISION MEASUREMENTS

by

A. W. Judge

A.R.C.S., D.I.C., WH.SC., A.M.I.A.E.

Second Edition, Revised

376 *pages* 384 *figures* 30*s. net*

ELECTRICAL ENGINEERING ECONOMICS

A Study of the Economic Use and Supply of Electricity

by

D. J. Bolton

M.SC., M.I.E.E.

[Vol. I.—General Principles and Use of Plant]

Third Edition, Revised

304 *pages* 18 *figures* 25*s. net*

ELECTRIC POWER SYSTEM CONTROL

by

H. P. Young

M.I.E.E., M.A.I.E.E.

Third Edition, Revised and Enlarged

472 *pages* 319 *figures* 28*s. net*

ELECTRICAL ENGINEERS' HANDBOOK

Edited by

H. Pender & W. A. del Mar

[Vol. I.—Electric Power]

Fourth Edition

1716 *pages* 997 *illustrations* 68*s. net*

37 ESSEX STREET, LONDON, W.C.2

CANADIAN RAILWAYS SEEK BRITISH GOODS

The two rail systems in the Dominion—Canadian Pacific and Canadian National—are seeking U.K. sources of supply for a wide range of goods. Goods worth $80,000,000 were bought in 1949 by Canadian National Railways alone. Until now, British participation in this trade has been small.

Most of the equipment needed by the Canadian railways is of different design and specification from that used in Britain, and the overseas markets which British manufacturers serve. The scale of Canadian requirements and the fact that orders from the two railways are likely to be repeated, however, make initial special tooling and other adaptation by British firms well worth while.

Trade Associations in all the relevant industries have already been asked by the Ministry of Supply to approach the Canadian railways for full details of their requirements. The London representatives whom firms can approach are :—Mr. F. Fawke, Purchasing Agent, Canadian Pacific Railways, 62 Trafalgar Square, W.C.2, and Mr. J. B. Thom, European Manager, Canadian National Railways, 15-19 Cockspur Street, W.C.2.

FIRST UNITED STATES INTERNATIONAL TRADE FAIR

MR. HAROLD B. BARTON, the Fair's European manager, announced that Registration fee for buyers at the First United States International Trade Fair, to be held in Chicago, August 7 to 20, has been set at $5.00.

The fee includes the International Trade Fair catalogue, reservations and hotel accommodation service, badge, and credentials authorizing unlimited access to and transportation between all buildings of the Fair. Other facilities to be provided for buyers include customs, translation, transportation and monetary exchange services.

RADIO COMPONENT SPECIFICATION

THE Radio Industry Council (of Great Britain), which last year published specifications for climatic and durability tests of components and for choice of materials, has now published the first of a series of specifications covering class, category and quality of components. This specification, No. RIC/122—Resistors Rotary Variable, Composition Track (with or without switches), is significant of the careful and detailed technical work now being undertaken jointly by all sections of the British radio industry under the auspices of the R.I.C. The intention is that all components in general use in the radio and electronic industries will eventually be covered in the series.

The new specification represents many months of work by the technical representatives of both manufacturers and users of components. It was prepared by the Technical Specification Committee of the R.I.C. in consultation with the constituent bodies of the Council, representing respectively the manufacturers of receivers, of communication, radar and electronic equipment, and of components (British Radio Equipment Manufacturers' Association, Radio Communication and Electronic Engineering Association and Radio and Electronic Component Manufacturers' Federation.) It was finally approved by the Technical Directory Board of the R.I.C. on which all four constituent associations are represented (the fourth being the British Radio Valve Manufacturers' Association).

The specification, in standard loose-leaf form, measuring 8 in. by 10 in., is in three sections as follows :

(1) Performance requirements ;
(2) Production tests ;
(3) Schedule of types, values, sizes.

Section 3 so far contains preliminary dimensional data only, but will eventually contain full details of dimensions, ratings and values.

For the time being the specification is meant for use internally within the industry, but it is intended to submit it eventually to B.S.I., by which time it may be found possible to co-ordinate the requirements of the industry and of the Services in one comprehensive national standard.

The Radio Industry Council is urging its members to make the fullest use of the specification.

The complete specification is obtainable from the Radio Industry Council, 59 Russell Square, London, W.C.1, price 3s. 6d., and the sections are available separately at 2s. 6d., 9d. and 3d. respectively. Amendments will be sent to those asking for them on buying the original specification.

"ONE OF THE FEW SHOPS IN THE COUNTRY DEALING ENTIRELY WITH ENGLISH AND AMERICAN TECHNICAL BOOKS"

HUDSON'S

BURLINGTON PASSAGE,

BIRMINGHAM, 2.

: :

'Phone: MID 0602 1719

'Grams: LITERATURE BIRMINGHAM

Catalogues Supplied on Request

Open all day on Saturdays.

Classified Advertisements.

The rate for all classified advertisements is 6d. per word ; in bold print 9d. per word ; minimum order 6s. Box number advertisements 1s. extra. Instructions together with remittance must be received not later than the 3rd of each month for advertisements to appear in the same month's issue.

SITUATIONS VACANT

A MECHANICAL ENGINEER is required for research work on plastic flow of metals at G.K.N. Research Laboratories, Wolverhampton. Applicants should have an honours degree in engineering and should have completed a period of practical training. Previous experience in research is not essential. The salary offered is in the range £400-500 according to age and experience. Applications giving full details of age, qualifications and experience should be made to the Director of Research, G.K.N. Research Laboratories, Ettingshall, Wolverhampton.

WANTED

BACK ISSUES OF THE ENGINEERS' DIGEST Wanted. Full price, 4/6 per copy, will be paid for each copy of the September and October, 1948, issues (Vol. IX., Nos. 9 and 10) and May, 1949 issue (Vol. X, No. 5). Double the original price, 9/- per copy offered for copies of the August, 1940, issue.—Send copies to the SUBSCRIPTION DEPARTMENT, "THE ENGINEERS' DIGEST," 120 Wigmore Street, London, W.1.

WORK WANTED

BOTTLENECK IN CASTINGS ? We can probably help you. Small part of our capacity available at the moment for precision ALUMINIUM gravity die castings, ZINC pressure die castings. High standard of workmanship ; established 1828.—Write or 'phone **Thos. Ashworth & Co., Ltd.** (Dept. A/15/4), Vulcan Works, Burnley, Lancs. (Burnley 3505).

FOR SALE

NISSEN TYPE HUTS, ex-Government stock, reconditioned and supplied ready for erection. All sizes in 6 ft. multiples. 36 ft. by 16 ft., £65 & £54 ; 24 ft. by 16 ft., £46 & £38 ; 72 ft. by 16 ft., £122 & £97 ; delivered U.K. Plasterboard huts and other buildings. Some 24 ft. span Nissens.—Write, call or telephone, **Universal Supplies (Belvedere) Ltd.,** Dept. 50, Crabtree Manorway, Belvedere, Kent. Telephone No. ERITH 2948.

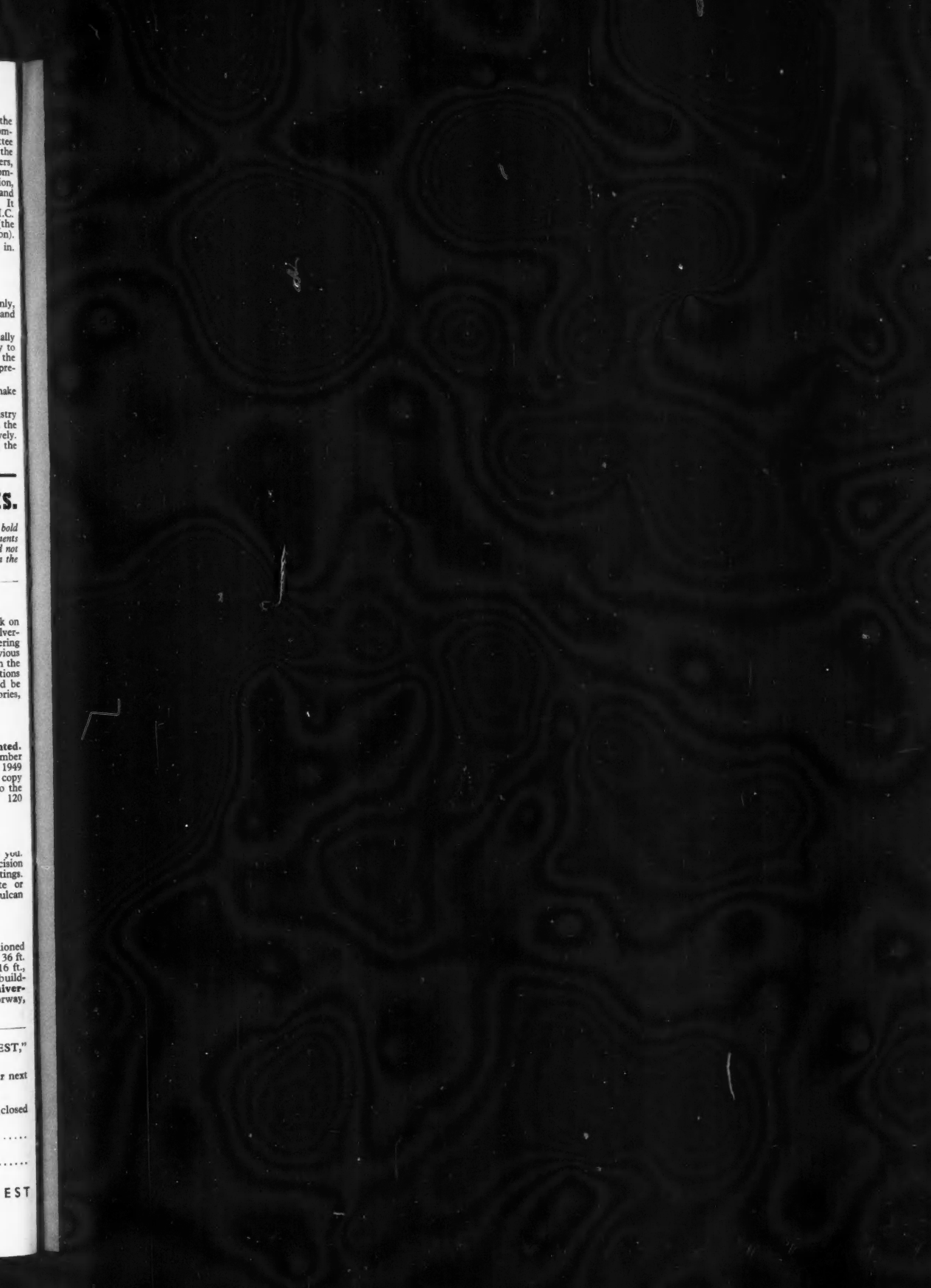
To the Advertisement Manager, "THE ENGINEERS' DIGEST," 120, WIGMORE STREET, LONDON, W.1.

Please insert the enclosed Classified Advertisement in your next available issue.

Cheque/Postal Order value..... for.....words enclosed

Name .....

Address .....



THE BLUE PAGES

A QUICK GLANCE AT THE LATEST TECHNICAL DEVELOPMENTS THROUGHOUT THE WORLD

● *CHROMIZING*

For some years past, a good deal of research has been devoted to the problem of providing a corrosion-resistant surface on carbon and low alloy steels by impregnating the surface with a non-corroding metal, such as chromium. Various methods of effecting the impregnation by diffusing the chromium into the iron are being developed. The main difficulty in the practical application of such processes appears to lie in the attainment of complete and uniform penetration. The chromizing methods developed in Europe either employ the cementation principle or involve the application of a chromium-bearing gas at high temperature to the surface to be treated ; a novel process of the latter type has just been announced in France. In the U.S.A., the possibility of using a chromium salt bath process has been investigated at the Battelle Memorial Institute and has resulted in highly favourable findings. The American investigators lay emphasis upon the ease and simplicity of application of the salt bath process and the uniformity and high corrosion resistance of the protective zone produced by this process in the surface of the material so treated.

● *STEAM ENGINE WITHOUT CYLINDER LUBRICATION*

The cylinder lubrication required in steam engines imposes severe limitations upon the permissible superheated steam temperature ; moreover, the exhaust steam is contaminated with oil and in many cases, therefore, cannot be utilised as process steam. A high-speed steam reciprocator has now become available in which cylinder lubrication is completely dispensed with by using a piston of special design, in which the necessary seal between piston and cylinder wall is effected by labyrinth grooves in the piston, the latter having no rubbing contact with the cylinder wall. The first engine of this type placed on the market is of the vertical completely enclosed design. It is equipped with diffusor-type valves operated from a separate camshaft, enabling the engine to run at normal speeds of 600 to 750 rpm. This engine is highly suitable for back pressure operation, particularly as its exhaust steam is as oil-free as that of a turbine. The single-cylinder model, with a stroke of six inches, develops 80 to 100 hp, according to steam pressure. A larger type of 200 hp is said to be under construction. Both types will be available as multi-cylinder units, with powers ranging from 80 to 500 hp. Engine efficiency is claimed to be high. The engine should be particularly suitable as a back pressure unit for food processing plants, breweries and paper mills, and, in general, for all applications where uncontaminated exhaust steam is required.

● *NEW ZINC ALLOY*

ZNCUBE (pronounced zin-cu-be) is the name given to a new alloy consisting of zinc with small additions of copper and beryllium, the development of which has just been announced in America. The alloy is claimed to possess approximately the same strength and electrical characteristics as brass, but to be considerably lower in cost. Its working strength is about eight times that of any zinc alloy now in use, it is stated by the inventor. Moreover, the inclusion of small, unspecified, percentages of copper and beryllium causes the zinc to take on a springy, resilient quality. Owing to its low cost, the new material may prove a successful substitute for brass, especially as it is claimed to be easily machined, soldered and resistance-welded. We would add that the use of beryllium as an alloying constituent for the purpose of imparting resiliency is not, of course, new in itself, considering the steadily increasing employment of beryllium-copper alloy as spring material.

● *NEW GERMAN PATENT LAW*

Since February last, the new German Patent Office, with headquarters in Munich (and lately with a branch office in Berlin), has been issuing a weekly gazette listing patent applications, patent grants and trade marks. The law establishing this Patent Office was promulgated in July, 1949, and since then additional legislation and rules laying down procedure have been published from time to time. Of particular importance to non-German nationals and firms is Law No. 8, issued on October 1st, 1949, which grants them full priority rights for inventions on which patent protection was applied for outside Germany at a date before October 1st, 1949, but not more than six months prior to the outbreak of the war. Such priority must, however, be claimed by appropriate patent application to the German Patent Office before October 3rd, 1950. An important feature of the patent procedure now

AIR FRANCE

The first Airline in the World

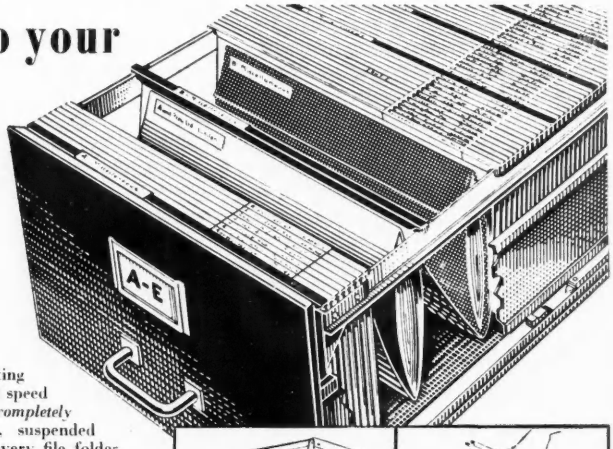
AIR FRANCE · 52 HAYMARKET · LONDON · S.W.1

TELEPHONE: WHITEHALL 0971

BIRMINGHAM · MANCHESTER · GLASGOW · BELFAST

Fit 'SPEEDAC' to your filing cabinets

for increased speed and accuracy . . .
for complete visibility

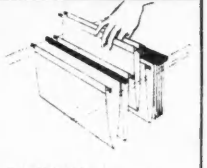


SPEEDAC

SUSPENSION FILING

can be simply and easily installed in your existing files. Immediately you will obtain the increased speed and accuracy of filing which result from its *completely visible* titling. A series of coupled pockets, suspended from a chassis, provides a labelled home for every file folder and a means of signalling its absence. Folders can be added to the sequence, or removed, with the greatest of ease. Simple to use, easy to install. Speedac will revolutionise your filing.

CHASSIS The Speedac chassis can be assembled in a few minutes and drops straight into your file drawer.



POCKETS Speedac pockets can be coupled or uncoupled in a few seconds. Titling is simple and speedy

Remington Rand

✱ *Write for Illustrated Folder:* REMINGTON RAND LIMITED (Dept. SP 94), 1 New Oxford St., London, W.C.1. Tel: Chancery 8888

adopted as a sort of emergency measure is that examination of applications for novelty is not carried out by the Patent Office. Applications are laid open to public inspection and opposition for a term of four months, and unless opposition is filed the patent is then granted. Needless to say, this procedure is apt to throw a particularly heavy financial burden upon non-German parties, who, to all intents and purposes, will be forced to arrange for watching briefs at the German Patent Office to guard against the grant of patents covering their own inventions to German nationals who may or may not be acting in good faith in claiming prior art of other countries as their own invention. This is a state of affairs which can hardly be called satisfactory.

● *EXTRUDED RIBBED SHEET*

An extremely ingenious, comparatively simple process has been devised for the production of aluminium sheet with integral closely spaced stiffening ribs for aircraft construction purposes. As it is not feasible to extrude flat sheet material of this type, the ribbed sheet is extruded from the press in the form of a tube having outside ribs. This tube is then slit lengthwise and opened up by a series of straightening and stretching operations to produce a flat ribbed sheet. The developed width of such a sheet is defined by the circumference of the tube extruded. The maximum width of sheet that can be produced must, therefore, depend upon the overall diameter of the tube (including ribs) that can be extruded. For a die opening of about 10 in., it is practical to extrude a 9-in. diameter shape, which can be slit and flattened to produce a ribbed sheet about 27 to 28 in. wide and having 14 stiffening ribs. The height of the ribs would appear to lie between 1 and $1\frac{1}{2}$ in. Accepting the die opening as the limiting factor, a die 20 in. in diameter would permit production of a ribbed sheet approximately 5 ft wide ; but a press designed for the formidable capacity of 15,000 tons would be needed, as compared with an actually available extrusion press capacity of 5,500 tons.

● *LUBRICATION OF GRAPHITE BY WATER VAPOUR*

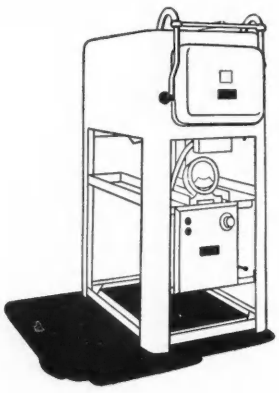
Graphite consists of layers of atoms which can easily slide over each other, and it was hitherto assumed that graphite is a good lubricant in itself. According to latest findings, the slippery properties of graphite are bound up with the presence of an invisibly thin film of moisture on the surface of the material. This has been demonstrated by testing the comparative wear of graphite brushes for electrical machines in dry and humid atmospheres respectively. Brush wear is an important point in the operation of electric motors and generators in aircraft flying at great altitudes in dry rarefied air. By shielding the brushes and supplying water vapour to the space around, brushes, which would formerly wear out in one hour in a dry atmosphere, are made to last from 2,000 to 8,000 hours. Certain organic vapours are said to be vastly more effective in this respect than water vapour, so that their presence in minute concentrations will be sufficient to provide adequate lubrication. The possibility of incorporating an appropriate volatile substance in the brush material would appear to suggest itself.

● *RADIANT GAS BURNER*

There is no doubt that many metal working processes could be considerably speeded up by cutting down the time required for heating or re-heating the material between production stages. The readiness of production engineers to apply new high-speed heating methods as they become available is well attested by the rapidly spreading application of high-frequency heating—and this in spite of the considerable cost of plant. It would appear that these successes have stimulated gas engineers to intensified efforts to improve gas heating methods. These efforts have culminated in the development of special types of radiant gas burners. These burners effect high-speed heating of material by the intense transfer of radiant heat developed by the burning of compacted gas-air mixtures against cup-shaped refractory surfaces forming part of the burner. Burners of this type may be designed for high-speed heating in any desired shape, ranging from uniform heating of moving wide material strip to the local heating without flame impingement required in the brazing of carbide tips.

● *DIELECTRIC PROPERTIES OF WOOD*

The use of high-frequency energy as a source of heat to cure synthetic resin glue in wood assemblies is a comparatively new process, and more information on the dielectric properties of various woods, i.e., dielectric constant and power factor, is essential. Preliminary data of this nature on Douglas Fir and Ponderosa Pine are now available. These indicate that in the frequency range investigated, the dielectric constant decreases with increasing frequency, and that it also greatly increases with the moisture content. Both the dielectric constant and the power factor increase with the wood density. The effect of grain direction relative to the electric field upon dielectric constant and power factor is more pronounced in the case of Douglas Fir than that of Ponderosa Pine. In general, both factors have the greater values if the grain direction is parallel to the electric field. The changes in dielectric constant and power factor with the temperature rise in the heating cycle call for slight electric adjustments if the input power is to be held constant.



There are

WILD-BARFIELD

ELECTRIC FURNACES

for all heat-treatment

purposes

ELECTRIC WILD BARFIELD FURNACES

Illustration shows Self-Contained Horizontal Workshop Furnace, for temperatures up to 1050°C

WILD-BARFIELD ELECTRIC FURNACES LTD.
ELECFURN WORKS, WATFORD BY-PASS, WATFORD, HERTS
Telephone: Watford 6094 (4 lines) Telegrams & Cables: Elecfurn, Watford

M-W-302

The hen can lay an egg in any position. She is a specialist. But we're just as clever with **nickel and nickel alloys** *— see!*

BRITISH DRIVER-HARRIS Co. LTD

GAYTHORN MILL, ALBION STREET, MANCHESTER, 15

ALSO AT LONDON & BIRMINGHAM

We will be glad to deal with your technical enquiries

"NICHROME" REGISTERED TRADE MARK

Copies of our 1950 catalogue on request

● *ELECTRIC SPARK MACHINING*

On several occasions, this journal has drawn attention to recent developments in the application of electric spark fragmentation processes to machining operations, and a report on important recent research in Hungary into electrical and physical aspects of the process will be found elsewhere in this issue. It would appear that, of late, spark cutting processes of various kinds have been introduced into Russian industry on a fairly large scale. According to Russian sources, electric spark cutting machinery can be utilised for the grinding of milling cutters and other cutting tools, and a number of Russian aircraft factories appear to be making full use of special machinery designed for this purpose. A recent report refers to experiments conducted for the adaptation of spark cutting devices to contour milling with the use of templates. While the report in question deals with the spark machining of milling cutters, the very fact that this new method is being widely used in Soviet aircraft factories would suggest that spark cutting may possibly also be finding application to the manufacture of gas turbine blading. This is, of course, mere speculation; but in any event the potentialities of spark cutting in this field or related fields would appear to be well worth close scrutiny.

● *REMOVING WORN-OUT ENAMEL COATINGS*

Enamelled vessels of the type used in chemical and process industries have occasionally to be freed of their old coating for the purpose of re-enamelling. The removal of the worn-out enamel coating is usually carried out by sand blasting. In view of the wear resistance of enamel, this is naturally a rather slow process, which, incidentally, also involves the danger of abrading the parent metal. A far more satisfactory method, recently discovered, is to bring a powerful ultrasonic generator into physical contact with the vessel; this process leads to the flaking-off of the enamel from the metal. The reason is, of course, that the more resilient parent metal is able to follow the rapid ultrasonic vibrations, while the brittle enamel is not capable of flexure. As a result, the bond between enamel and metal surface is destroyed and the enamel falls off. This process dispenses completely with manual labour, and all that is required is to place the vessel to be cleaned upon a base connected with an ultrasonic generator.

● *NOVEL METHOD OF COMPRESSOR BLADE MANUFACTURE*

Both powder metallurgists and production engineers will find much valuable information in a recent report which describes the development of a novel process to produce high-strength compressor blades by powder-metallurgical methods. Hitherto, the main obstacle to the application of high-strength parts has been the residual porosity of the product, which is difficult to eliminate by conventional methods. It was, therefore, decided to attempt solution of the problem by filling in the pores in the iron pressing by the infiltration of copper. Another formidable difficulty encountered was shrinkage. Systematic solution of these problems finally led to a process in which the product has an ultimate tensile strength of 90,000 psi, the elongation being 8 per cent. Salient technical data on the process are given in a British Patent Specification just published, in which both shrinkage control and attainment of a smooth pore-free surface are specifically referred to.

● *HOMOPOLAR WELDING GENERATORS*

A few homopolar generators for the generation of direct current of low voltage and high amperage were built by both Westinghouse and General Electric in America some forty years ago, but this type of generator subsequently came to be considered as no more than an interesting item in textbooks on electrical machinery. It has now been discovered, however, that the homopolar machine presents attractive possibilities as a source of d.c. current for resistance welding. By applying advanced engineering concepts to the design of homopolar machines, a resistance welding unit has been developed which offers important advantages over conventional equipment. Moreover, it is especially suitable for spot-welds on aluminium and projection welds on steel. Tentative designs have also been prepared for an engine-driven generator to supply a portable flash welder for field use, providing maximum currents in excess of 150,000 amperes. The adoption of equipment of this type for military purposes is also said to be under consideration.

● *YARN TENSION CONTROL BY MAGNETIC DRAG*

Field trials are now being made with a magnetic drag device or hysteresis brake designed to produce constant yarn tension in textile machinery. This device eliminates the disadvantages inherent in tension control by friction. It consists of a rotor and a stator, both containing "Alnico" magnets, which are so arranged that the magnetic drag or hysteresis effect remains constant at all speeds of rotation. The yarn passes around a pulley forming part of the hysteresis brake; and the latter will apply tensions which can be adjusted over a range of $3\frac{1}{2}$ to $10\frac{1}{2}$ gram-inches at speeds up to 700 yards per minute, it is stated. The lower torque limit of this device is governed largely by the type of bearings used; and it is not, of course, desirable to produce torques so low that the torque characteristics will be affected by variations in bearing friction. Devices incorporating this principle may also prove useful in fine wire coil winding and similar operations.

HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL · HOCUT "G" – THE **NEW** SOLUBLE OIL ·

"Hocut G"

HOCUT "G" is extremely fluid; cools and penetrates rapidly. Will not stain or cause rust; remains stable indefinitely. Forms a translucent solution through which the work can be seen. Has a pleasant odour, is antiseptically treated and will not turn rancid. HOCUT "G" will not precipitate and sludge or gum slides. Acts as a temporary rust preventative.

Experience, skill and research have combined to make HOCUT "G" the Pre-eminent Solible Oil for grinding and machining operations.

Descriptive Folder on request.

A PRODUCT OF *Edgar* **Vaughan** & Co Ltd

BIRMINGHAM 4, ENGLAND

Over 50 years Leadership in Service to the Metal Working Industry

Works: Birmingham · Manchester · Liverpool · Southall · Bristol · Glasgow

• *SPRAYING PAINT WITH STEAM*

A recently developed process for spraying organic finishes in conjunction with superheated steam is claimed to offer several advantages over conventional paint spraying methods. Owing to the combined heating and atomizing action of the steam, re-heating of the paint is not required. In fact, the heat of the steam permits the spraying of paints of higher viscosities, thus making possible a reduction in the volatile material contents and producing a faster coverage of the work. Steam spraying may be done at the same pressure and with the same type of gun as used in compressed air spraying. Because of the high temperature of the steam, the gun handle and trigger must be heat-insulated. New types of guns especially suited for steam spraying are under development. Both reduced high-pressure steam and superheated low-pressure steam have been used with good results. One user of steam spray equipment reports a saving of approximately 15 per cent in material, with less overspray. In order to improve economy and speed of spray painting processes in general, several methods of spray contour control have been developed, and a recent British patent describes a novel type of spray nozzle incorporating a device " to produce sprays of widely varying contour without resorting to different spray nozzles."

• *HOT-SPOT MACHINING*

In last month's issue (pp. 126-128), we reported in some detail on an investigation into the possibilities of hot-spot machining. This is a process which involves localised heating of the workpiece ahead of the cutting tool for the purpose of increasing the rate of metal removal. Latest cutting tests have now confirmed previous findings. A metallurgical investigation has been conducted on steels machined at room temperature, and at 600 to 700, 1,000, and 1450° F. This study, which involved microhardness surveys, microstructure examinations, and surface analyses, has proved that localised heating for machining has no deleterious effects on the hardness, surface condition and microstructure of finished parts. In fact, the surface condition resulting from high-temperature machining is claimed to be better than that obtained from room-temperature machining. Residual stress examinations were, however, far from conclusive, the findings being " erratic, confusing, and impossible of explanation "; and " considerably more work must be done on the study of residual stresses before any conclusions can be reached."

• *PLASTIC DEFORMATION OF METALS*

There is little doubt that the methods followed in cold-forming processes of metals could be greatly improved if more were known about the nature of the plastic flow of metals. Noteworthy efforts have been made in recent years to gain deeper insight into the complex phenomena involved in plastic flow, and the paper by Sir Andrew McCance on the plastic behaviour of solids, read as the Fourth Hatfield Memorial Lecture last year, has done much to place the theory of plastic behaviour on a firmer foundation. Experimental technique until now has largely relied upon the study of grain orientation by X-ray diffraction methods. Recently, D. H. Woodward, of the National Bureau of Standards, Washington, in the course of a study of plastically deformed Monel metal, has developed a novel technique which employs polarised light to render visible any differences in crystal orientation resulting from plastic deformation. This method may well prove an important tool in future studies of plastic deformation of metals in general, and the original paper should, therefore, deserve close attention on the part of research workers in this highly important field.

• *MAGNETIC FLUID CLUTCH*

By magnetizing a fluid consisting of a mixture of oil and finely divided iron powder, the fluid may be instantly changed from the liquid to the nearly solid state. This phenomenon was originally discovered in 1948 at the National Bureau of Standards, Washington, where a clutch employing the magnetic fluid as coupling means was also developed. (See *The Engineers' Digest*, August, 1948). Commercial applications of magnetic fluids to various mechanical devices, such as shock absorbers, dashpots, and couplings, are being developed by several engineering concerns in the United States. Thus, it has just been announced that at the General Engineering and Consulting Laboratory of the General Electric Company, Schenectady, an improved magnetic-fluid clutch has been built which is only 6 in. long and 6 in. in diameter, yet is capable of transmitting more than 60 hp. However, this design has not yet reached the manufacturing stage. This particular clutch contains two coupling elements in the shape of metal cylinders separated by the magnetic fluid. The coupling effect may be adjusted so that the clutch can be allowed to slip if required. A novel feature is claimed to be the provision of rectangular teeth on the clutch faces, which increases the grip between the magnetic fluid and the coupling elements. Magnetic fluid clutches made in Great Britain are now on test by the Defence Establishments with a view to applying them to servo-mechanisms.

For further information on developments reviewed in THE BLUE PAGES, readers are invited to write to the Editor.

BEETLE W.20

QUICKER STOVING—NEW BEETLE CORE-BINDING RESIN SPEEDS PRODUCTION

Since January we have been making deliveries in quantity of Beetle W.20, the new core-binding resin. Already we have reports of increased production due to quicker stoving and of many other advantages that Beetle W.20 offers. Consider these points in relation to your own problems:

Good dry strength (green bond agents are added for green strength).

Low viscosity makes W.20 easy to handle.

Considerable latitude in stoving temperatures is possible. Hardening is not dependent on oxidation.

Permeability of cores is not reduced by W.20.

Total gas evolution during pouring is less than that of most oil-binders.

Fumes are less troublesome than with linseed oil; odour has been reduced to a minimum.

Knock-out properties are exceptionally good.

The materials used to make W.20 are British. There are no supply difficulties. Delivery is quick.

Write for Technical Leaflet C.B.1 to:—

BEETLE BOND LTD., 1 Argyll Street, London, W.1

B·I·P GROUP

'BEETLE' is a trade mark registered in Great Britain and in most countries of the world